Canada Alberta

FOREST RESOURCE DEVELOPMENT AGREEMENT
ENTENTE SUR LA MISE EN VALEUR DES RESSOURCES FORESTIERES

Canada Alberta

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The Canada-Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by Forestry Canada and the Alberta Forest Service.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est auxiliaire à l'Entente Canada-Alberta sur le développement économique et régional, qui vise à assurer la coordination et la coopération des deux gouvernements relativement au développement économique de l'Alberta.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par Forêts Canada et le Service forestier de l'Alberta.

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Mixed Species

Summary Report

Forestry Department
Alberta Research Council[1]

1990

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Summary

The objective of this continuing project is to evaluate and facilitate the use of under-utilized wood fibre sources for panel manufacture.

For this year, the species of focus was black poplar.

The project was carried out in three separate parts, corresponding to the three main objectives:

I. Logs of aspen and black poplar were waferized on a lab waferizer at 4 temperatures (-10°C, 5°C, 20°C and 50°C) and 2 moisture content levels ("green" and "semi-dried" or approximately 70% moisture content) to determine the effect of temperature and moisture content on strand yield and quality. Analysis of the produced furnish showed that for both species the best conditions for waferizing was high log temperature (50°C) and low log moisture content ("semi-dried")

II. Strands of aspen and black poplar were dried in a walk-in oven at 4 temperatures (50°C, 100°C, 125°C and 150°C) levels to determine the effect of drying temperature on OSB quality. Panels made on the 2' x 4' press showed the higher drying temperature slightly lowered internal bond of aspen panels but also slightly lowered thickness swell for both aspen and black poplar panels. Other properties did not seem to be effected by drying temperature.

III. A pilot plant and mill trial were conducted using black poplar in the face and aspen in the core of OSB. 11.1 mm x 1220 mm x 2440 mm OSB made at the ARC Pilot Plant showed only small lessening of properties with the addition of black poplar to the OSB. The panels made in the mill trial were of too low density (600 kg/m^3) to compare directly with regular production. However, other than for MOR in the parallel direction the test panels with black poplar in the face exceeded all CAN3-0437.0 0-2 requirements.

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1. OBJECTIVES AND GOALS

The objective of this continuing project is to evaluate and facilitate the use of under-utilized wood fibre sources for panel manufacture.

For this year, the species of focus was black poplar. The specific objectives are listed in Schedule "A" of the contract (reproduced in Appendix A).

In summary these objectives were:

I To determine the effect of temperature and moisture content on strand yield and quality using aspen and black poplar in the laboratory.

II To determine the effect of drying temperature on dry strand yield and quality using aspen and black poplar in the laboratory.

III To carry out a mill trial based on the previous results and all other available knowledge.

2. INTRODUCTION

This project was carried out in three separate parts, corresponding to the three main objectives. As such, the results of each of these parts are reported in the following three sections:

I Temperature and Moisture Content Effects

II Drying Temperature Effects

III Pilot Plant and Mill Trial

The cumulative results of these sections are summarized in the final section "Conclusion and Recommendations from the 1989/90 Mixed Species Project."

3. PART I - TEMPERATURE AND MOISTURE CONTENT EFFECTS

3.1 Objectives and Goals

The objective of this part of the project was to determine the effect of temperature and moisture content on strand yield and quality using aspen and black poplar in the laboratory.

3.2 Introduction

In previous Mixed Species projects, ARC has reported difficulty waferizing black poplar both in a laboratory and mill environment. One reason for this difficulty seems to be the result of the high moisture content of black poplar, approximately 150%. The effect of wood infeed temperature on waferization has not been evaluated by ARC. However, the common belief in industry is that wood at a temperature slightly higher than freezing (approximately 5°C) will waferize best.

The plan for this part of the project was to waferize both aspen and black poplar at varying moisture contents and temperature levels to determine the best wood conditions for waferizing these species. A matrix of four temperature levels (-10°C, 5°C, 20°C and 50°C) and two moisture content levels ("green" and "semi-dried" or approximately 70% moisture content) were evaluated for each species.

3.3 Methods and Materials

3.3.1 Wood Preparation

One aspen and one black poplar tree were harvested in early June from an active logging site near Slave Lake, Alberta. The two trees were growing beside each other and were of approximately the same age, height and diameter as shown in Table 1.

Table 1. Comparison of age, height and DBH of trees harvested for Part I.

Wood Species	Age	Height	Diameter at Breast Height
aspen	59	21.9 m (72 ft)	290 mm (11.4 in)
black poplar	63	17.4 m (57 ft)	270 mm (10.7 in)

Both trees were cut approximately 0.3 m (2 ft) from the ground and then cut at 2.1 m (7 ft) intervals. Figure 1 shows 50 mm thick discs cut from the ends of each 2.1 m length. These were measured for diameter, moisture content and density. These measurements are shown in Table 2.

Table 2. Comparison of diameter, moisture content and specific gravity along tree height of trees harvested for Part I.

Wood Species	Segment (height)	Diameter	Moisture Content	Specific Gravity
aspen	0.6 m (2 ft)	330 mm (13 in)	65	0.46
	2.7 m (9 ft)	270 mm (10.75 in)	78	0.43
	4.9 m (16 ft)	250 mm (10 in)	77	0.45
	7.7 m (23 ft)	240 mm (9.25 in)	78	0.43
	9.1 m (30 ft)	220 mm (8.5 in)	96*	-
	11.3 m (37 ft)	190 mm (7.5 in)	94*	-
black poplar	0.6 m (2 ft)	280 mm (11 in)	161	0.32
	2.7 m (9 ft)	250 mm (9.75 in)	137	0.33
	4.9 m (16 ft)	210 mm (8.25 in)	124	0.33
	7.7 m (23 ft)	200 mm (7.75 in)	115	0.37
	9.1 m (30 ft)	170 mm (6.5 in)	132*	-
	11.3 m (37 ft)	130 mm (5 in)	124*	-

* Moisture content taken with bark removed.

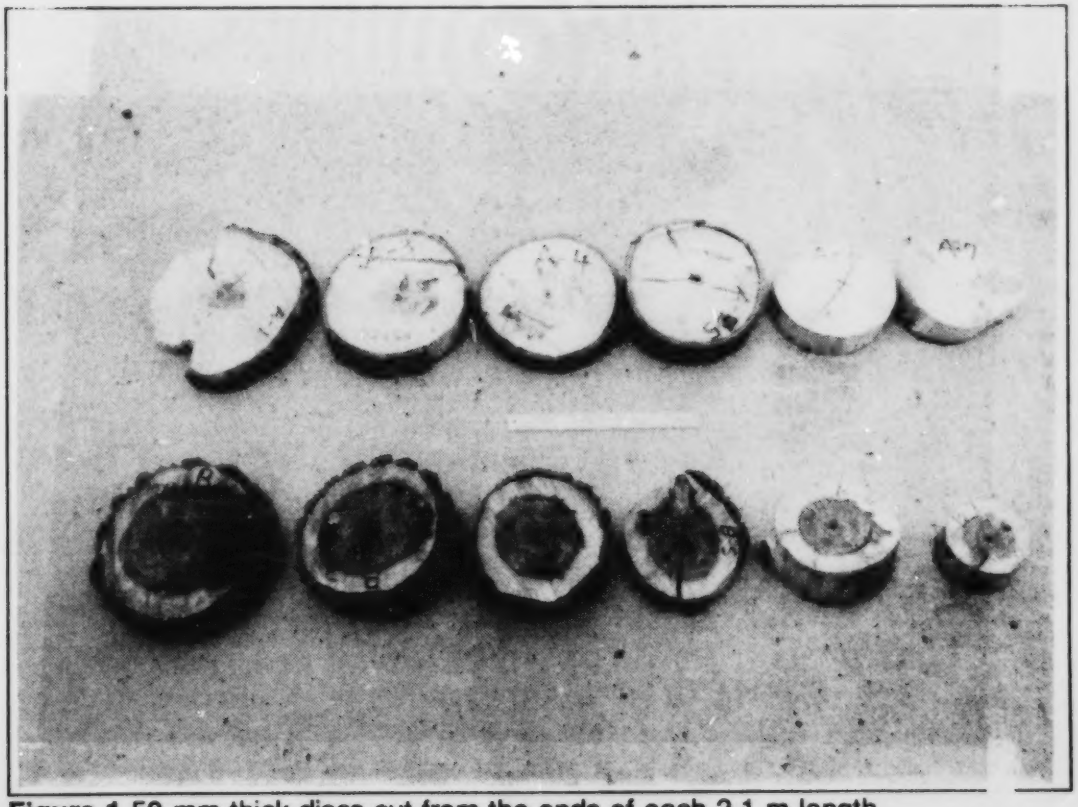

Figure 1 50 mm thick discs cut from the ends of each 2.1 m length.

The logs were debarked by hand and then further cut to 150 mm (6 in) lengths. These small 150 mm logs were split into sections with widths of 100 mm to 150 mm. These dimensions were required to enable the logs to pass through the 150 mm x 150 mm opening on the laboratory disc waferizer. Any rot was removed from the split logs.

The split logs were separated into eight groupings for each wood species. Each group contained approximately equal amounts of wood from each section of the tree. These groups were then conditioned to four temperatures (-10, 5, 20 and 50°C) and two moisture conditions (green and "semi-dried") as shown in Table 3.

Table 3. Experimental design showing weight of wood in kg conditioned for each group.

Wood Species	Moisture Content Group	Temperature Group			
		- 10°C	5°C	20°C	50°C
aspen	green	33	26	25	26
	semi-dried	26(22)	24(21)	26(23)	26(24)
black poplar	green	20	19	20	19
	semi-dried	19(13)	24(17)	20(14)	20(13)

Note: Numbers in brackets are the weights measured after conditioning.

The "green" blocks were immediately wrapped in plastic bags.

The "semi-dried" blocks were dried at room temperature (approximately 20°C) until the moisture content appeared to reach 70%. These were then also wrapped in plastic bags.

Both the "green" and "semi-dried" blocks were conditioned to target temperatures using a freezer for groups conditioned to - 10°C and 5°C and a walk-in oven for groups conditioned to 20°C and 50°C.

3.3.2 Strand Preparation

The wood was waferized on a CAE Machinery Ltd. Laboratory Disk Waferizer. Settings were made to produce a 0.64 mm (0.025 in) thick, 75 mm (3 in) long strand. The machine settings are shown in Table 4.

Table 4. Machine settings for laboratory disk waferizer.

Parameter	Setting
Working Speeds	
Disk RPM	1060 RPM
Feed Rate	1.35 min.
Knife Settings	
Thickness	7.9 mm
Wedge Angle	32°
Carrier Angle	35°
Serration	75 mm
Projection	0.64 mm
Counter Knife Settings	
Thickness	7.9 mm
Wedge Angle	60°
Projection	-2.0 mm average
Reactor Knife Settings	
Thickness	12.7 mm
Wedge Angle	20°
Projection	-14.0 mm average
Feed Works	
Spout to Disk Clearance	1.0 mm
Opening Distance	150 mm

The knives were cleaned and inspected after each run. The knives were replaced after all the wood at -10°C had been waferized. The frozen blocks showed noticeable wear on the knives.

3.3.3 Strand Analysis

Strands from all groups were measured for moisture content (green strands), screen fractions, strand geometry, bulk density and surface condition.

The moisture content for the strands coming out of the waferizer was measured. All moisture content calculations are based on oven dry basis.

The screen fractions were determined using a Williams Standard Pulp testing apparatus (Williams Classifier). Approximately a 0.03 m^3 sample was used for each measurement. The screen fractions were measured after the classifier had been operating for 5 minutes. Three repetitions were made for each group.

The strand geometry (strand thickness, length and width) were measured from a representative sample of 100 strands from each group. Fines which passed through the 3/8" holes on the Williams Classifier were not measured.

The bulk density of each group was determined using the apparatus shown in Figure 2. For each measurement the strands were slowly dropped through the serpentine until the bottom bucket filled to the 283 mm depth. Three measurements were made of each group.

The strand surface condition (roughness or smoothness) was measured from a sample of 50 strands from each group. The analysis was done by separating the sample of 50 strands first into two type categories (tangential and radial) and then three surface condition categories (rough, semi-rough and smooth). The average surface condition for both the tangential and radial categories was determined by assigning a weighting factor of 3 to the rough category, 2 to the semi-smooth category and 1 to the smooth category. The tangential and radial categories were then averaged to give one surface condition to each group.

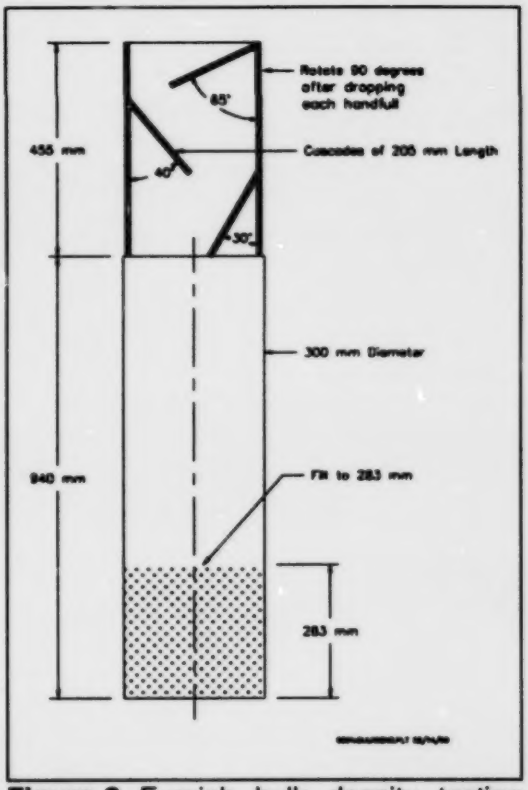

Figure 2 Furnish bulk density testing apparatus.

3.4 Results and Discussion

The moisture contents of strand samples taken after waferization is shown in Table 5. The moisture content of the aspen "green" groups was approximately 105% compared to 160% for the black poplar "green" groups. The moisture content of the "semi-dried" groups varied between 58% and 90%.

Table 5. Moisture content of furnish collected during waferizing.

Wood Species	Moisture Content Group	Temperature Group			
		- 10°C	5°C	20°C	50°C
aspen	green	115	101	101	101
	semi-dried	69	80	59	73
black poplar	green	175	158	162	153
	semi-dried	86	79	90	58

The screen fractions measured with the Williams Classifer are shown in Figures 3 to 6. As can be seen from these figures, a higher wood temperature at waferization produced less fines and larger strands in all instances. Similarly the "semi-dried" groups had less fines and larger strands than similar "green" groups.

A higher percentage of fines corresponds to a lower strand yield as shown in Figure 7. It should be noted that if yield is defined as a ratio of output weight at 6% MC over the input weight at "green" moisture content, then the black poplar yield in comparison to aspen is primarily influenced by the differences in "green" moisture content rather than the percentage of fines produced.

The aspen groups had less fines than the black poplar groups at similar temperature and moisture content conditions. However, only a small difference in screen fractions could be noticed between the aspen and black poplar "semi-dried" groups. These results would seem to indicate that the high "green" moisture content in black poplar is at least partly responsible for the difficulty reported in its waferizing. These results are also consistent with those obtained in previous Mixed Species projects.

The measurements of bulk density for the groups is shown in Figure 8. The bulk density of material did not seem to be affected by temperature or moisture content except for furnish obtained from frozen logs which had lower bulk density. However, the difference between aspen and black poplar is quite significant. The average bulk density (omitting the frozen groups) of the aspen groups was 66 kg/m^3 and only 48 kg/m^3 for the black poplar groups.

The strand geometry measurements are contained in Appendix B and summarized in Tables 6 through 8.

The surface condition (Figure 9) of the strands appeared most effected by log moisture content. For both species, the surface of the flakes was smoother for strands from "semi-dried" logs for similar log temperature conditions. Strands of both species from "semi-dried" logs had similar surface conditions. Higher log temperatures also seemed to improve the surface smoothness of the strands.

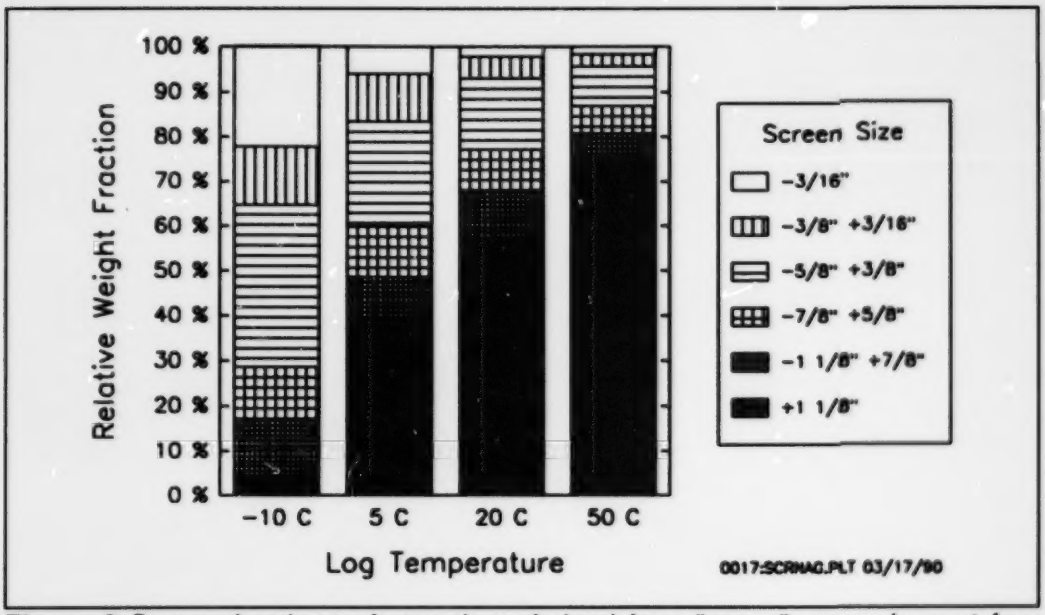

Figure 3 Screen fractions of strands waferized from "green" aspen logs at four temperature conditions.

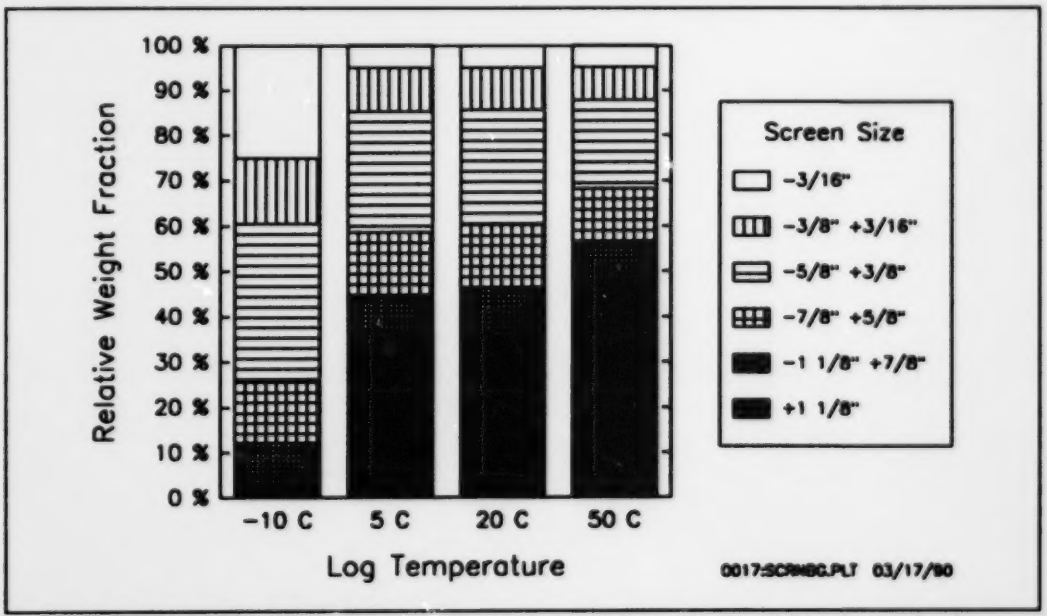

Figure 4 Screen fractions of strands waferized from "green" black poplar logs at four temperature conditions.

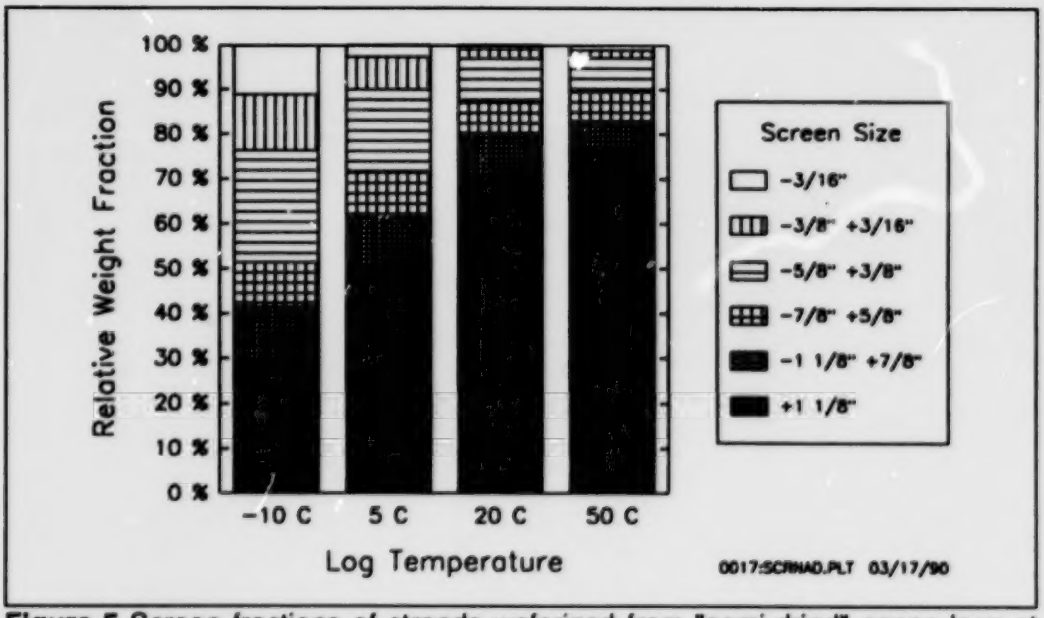

Figure 5 Screen fractions of strands waferized from "semi-dried" aspen logs at four temperature conditions.

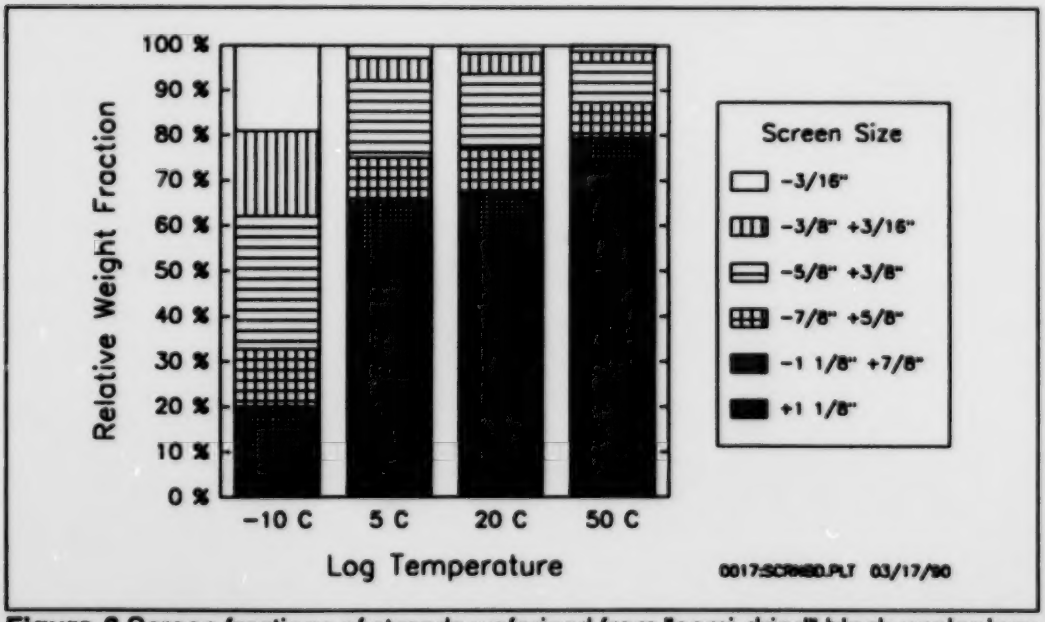

Figure 6 Screen fractions of strands waferized from "semi-dried" black poplar logs at four temperature conditions.

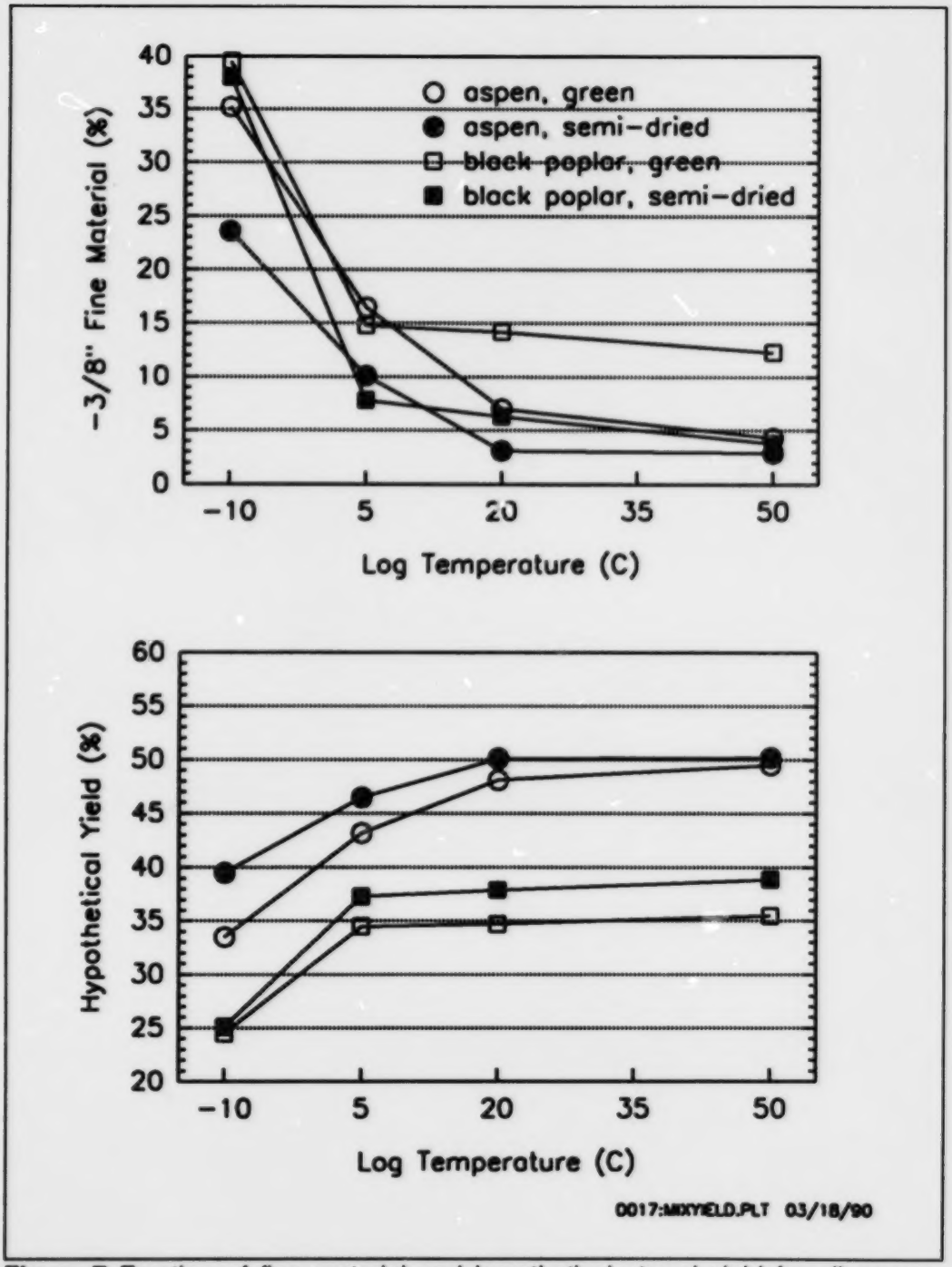

Figure 7 Fraction of fine material and hypothetical strand yield for all groups. (note: hypothetical yield is defined as -3/8" screened furnish at 6% MC over "green" log weight with bark and rot removed.)

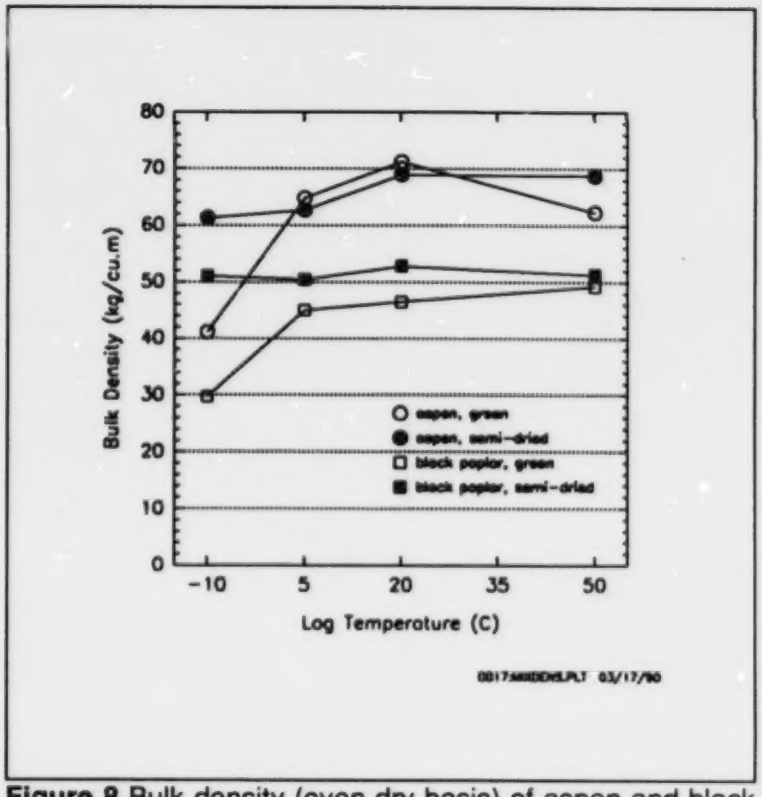

Figure 8 Bulk density (oven dry basis) of aspen and black poplar furnish.

Table 6. Summary of measurements of strand thickness.

Wood Species	Log Moisture Content	Measure	Log Temperature			Average
			5°C	20°C	50°C	
aspen	"green"	Mean S. Dev.	0.61 0.29	0.59 0.19	0.61 0.20	0.60
aspen	"semi-dried"	Mean S. Dev.	0.59 0.19	0.57 0.14	0.57 0.16	0.58
Average for aspen			**0.60**	**0.58**	**0.59**	**0.59**
black poplar	"green"	Mean S. Dev.	0.55 0.27	0.62 0.25	0.63 0.29	0.60
black poplar	"semi-dried"	Mean S. Dev.	0.67 0.18	0.59 0.15	0.62 0.21	0.63
Average for black poplar			**0.61**	**0.61**	**0.63**	**0.61**

Note: Sample size is 100.

Table 7. Summary of measurements of strand length.

Wood Species	Log Moisture Content	Measure	Log Temperature			Average
			5°C	20°C	50°C	
aspen	"green"	Mean S. Dev.	51.8 22.5	60.1 21.2	58.8 21.4	56.9
aspen	"semi-dried"	Mean S. Dev.	53.1 22.0	62.4 19.0	57.0 22.6	57.5
Average for aspen			**52.5**	**61.3**	**57.9**	**57.2**
black poplar	"green"	Mean S. Dev.	40.8 21.9	48.4 22.3	41.6 23.3	43.6
black poplar	"semi-dried"	Mean S. Dev.	54.8 21.4	51.8 22.1	57.1 22.1	54.6
Average for black poplar			**47.8**	**50.1**	**49.4**	**49.1**

Note: Sample size is 100

Table 8. Summary of measurements of strand width.

Wood Species	Log Moisture Content	Measure	Log Temperature			Average
			5°C	20°C	50°C	
aspen	"green"	Mean S. Dev.	7.5 6.6	11.5 8.0	14.0 15.3	11.0
aspen	"semi-dried"	Mean S. Dev.	8.9 7.2	9.7 7.5	13.5 15.0	10.7
Average for aspen			**8.2**	**10.6**	**13.8**	**10.9**
black poplar	"green"	Mean S. Dev.	7.5 4.6	9.4 7.0	9.0 7.5	8.6
black poplar	"semi-dried"	Mean S. Dev.	10.7 10.3	10.8 7.6	17.0 14.3	12.8
Average for black poplar			**9.1**	**10.1**	**13.0**	**10.7**

Note: Sample size is 100

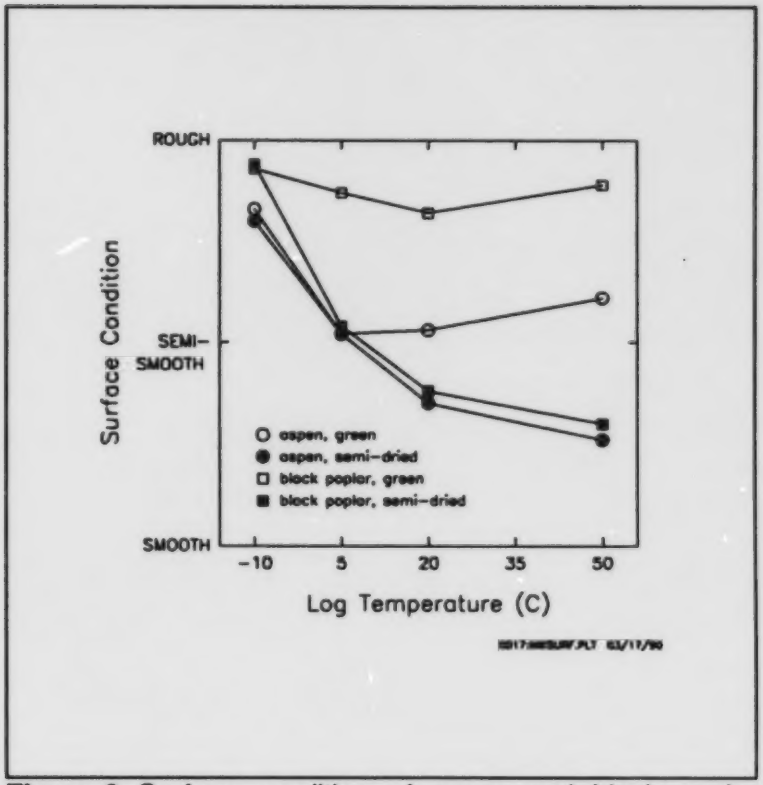

Figure 9 Surface condition of aspen and black poplar furnish.

3.5 Conclusions

From waferizing aspen and black poplar at varying moisture content and temperature conditions in the ARC pilot plant it can be concluded that:

1. strand yield and quality is increased with lower moisture content and higher temperature,

2. at "green" moisture content strand yield and quality of aspen is superior to black poplar,

3. at a moisture content of about 70% the strand yield and quality of aspen and black poplar is comparable for similar temperature levels, and

4. the bulk density of black poplar is approximately 25% lower than aspen.

4. PART II - DRYING TEMPERATURE EFFECTS

4.1 Objectives and Goals

The objective of this part of the project was to determine the effect of drying temperature on dry strand yield and quality using aspen and black poplar in the laboratory.

4.2 Introduction

Previous work at the ARC panel development pilot plant has shown very little to no difference in properties of OSB made of aspen and black poplar. However, commercial OSB mills trying to use black poplar have indicated significant reductions in properties of OSB made from black poplar rather than aspen. It is possible that these observed differences between pilot plant and mill experience is due to differences in the drying processes—the mill using high temperature and the pilot plant relying on near ambient temperatures to dry the strands. This effect would be amplified for a mill trying to use black poplar in their process because of the higher temperatures which would be required to dry the wetter black poplar furnish. More specifically, because black poplar needs more heat to be dried, its surface temperature would be raised higher than that of aspen. The higher surface temperature, it is assumed, would reduce panel properties.

Part II of this project was designed to evaluate the effect of drying temperature on OSB properties. To do this in a pilot plant setting, without access to a commercial dryer, it was decided that by stabilizing the temperature of the furnish at varying levels would best stimulate the drying effects in the mill and best exemplify the hypothesis that a higher strand surface temperature reduces panel properties.

The plan for this part of the project was to stabilize the temperature of aspen and black poplar furnish to four temperature levels (50°C, 100°C, 125°C and 150°C), then make panels from this furnish to determine whether or not there was any effect on panel properties.

4.3 Methods and Materials

4.3.1 Strand Preparation

Five aspen and five black poplar trees were harvested in August from Nojack, Alberta. The trees age, diameter at breast height, tree height and moisture content is shown in Table 9. In total 2600 lb. of green aspen wood and 2800 lb. of green black poplar wood was harvested and brought back to the ARC Mill Woods facility.

Table 9. Comparison of age, height, DBH and moisture content of trees harvested for Part II.

Tree	Age	Height (m)	Diameter at Breast Height (mm)	Moisture Content* at Breast Height (%)
aspen #1	32	16	170	70
aspen #2	35	16	210	75
aspen #3	52	16	300	94
aspen #4	50	14	200	95
aspen #5	63	17	210	95
aspen average	46	16	220	86
black poplar #1	43	14	240	120
black poplar #2	32	14	160	110
black poplar #3	46	17	250	90
black poplar #4	55	18	340	126
black poplar #5	55	-	250	119
black poplar average	46	16	250	113

* Note: Moisture content includes bark.

Logs of 610 mm length were cut and then soaked in hot tap water (approximately 50°C) to allow the bark to be removed easier. The logs were debarked by hand as shown in Figure 10.

The debarked logs were split into sections with widths no greater than 150 mm and then finally cut to 150 mm length. These sections of approximately 150 mm x 150 mm were waferized on the CAE Machinery Ltd. Laboratory Disk Waferizer. Settings were made to produce a 0.64 mm (0.025 in.) thick x 75 mm (3 in) long strand.

The settings were similar to the ones used in Part I of this study, except that a light spray of water was used during flaking (see Table 4). The cutting knives were replaced after approximately

Figure 10 Debarking logs by hand.

half of the aspen and half of the black poplar were waferized.

Strands produced from both aspen and black poplar were forced air dried down to approximately 8% moisture content. The material was then screened to remove -3/16" fines on the pilot plant vibrating flat bed screen.

4.3.2 Strand Temperature Conditioning

Four 30 kg samples of aspen and black poplar strands were taken and dried at varying temperatures in a walk in oven. The oven was set to one of four temperatures (50°C, 100°C, 125°C and 150°C) for each species. The material was then left in the oven for approximately 1 hour with a drum inside the oven slowly rotating to evenly distribute the heat. The one hour allowed the temperature of the strand to reach the set oven temperature.

4.3.3 Panel Manufacture

Three panels were made from each group of furnish on the 2'x4' press. All the panels were made to specifications shown in Table 10.

Table 10. Panel specification in Part II.

resin	powdered phenol formaldehyde 2.5% resin content
wax	hot slack wax 1.0% wax content
target density	640 kg/m^3
target thickness	11.1 mm
mat dimensions	710 mm x 1260 mm
panel dimensions	610 mm x 1220 mm trimmed
panel construction	single layer random orientation
platen temperature	206°C
pressing time	270 s

The 30 kg of conditioned material was put inside a batch drum blender of 1220 mm diameter and 610 mm depth. Water was first sprayed on the furnish to attain an equivalent moisture content for all groups of approximately 5%. Wax was then sprayed onto the furnish, followed by the addition of resin.

The prepared furnish was formed by hand on top of a commercial wire mesh screen. The mats were then pressed in the 2'x4' press. All pressing schedules were run to position set point to allow consistent closing and degass times. A sample pressing schedule for aspen and black poplar are shown in Figures 11 and 12. The remaining schedules can be obtained from the Alberta Research Council Forestry department on request. There were no apparent

differences in pressing the different groups. All the panels were labelled as shown in Table 11.

Table 11. Experimental design for Part I, showing group labels.

Wood Species	Drying Temperature			
	50°C	100°C	125°C	150°C
aspen	A1	A2	A3	A4
black poplar	B1	B2	B3	B4

Note: the panels were numbered 1 to 3 for each group (e.g. A1-1, A1-2, A1-3)

4.3.4 Strand Analysis

As previously explained, because of differences between a pilot plant walk-in-oven and commercial dryers, this part of the project could only simulate a commercial dryer in terms of attained strand surface temperature. Because the furnish for this study was dried for an equivalent amount of time at similar conditions, other than temperature, there was no reason the strands would be any different from one another in terms of size or bulk density. As such, for this study, strand analysis was only performed on aspen and black poplar strands prior to the temperature conditioning.

The aspen and black poplar strands were analyzed for screen fractions, strand geometry and bulk density to procedures described in section 3.3 for Part I of this study. The screen fractions were determined after the initial screening to remove -3/16" fines. The fraction of -3/16" fines removed was also measured for comparison.

4.3.5 Panel Testing

Three panels from each group were tested for modulus of rupture (MOR), modulus of elasticity (MOE), internal bond (IB), MOR after 2h Boil, thickness swell (TS) and linear expansion (LE) - oven dry to saturated. These tests were performed in accordance with CAN3-0437.1-M85 "Test Methods for Waferboard and Strandboard".

4.4 Results and Discussion

4.4.1 Strand Analysis Results

The moisture content of the aspen strands was measured to be approximately 120% and of the black poplar was about 160%.

Screening of the dried strands removed 5.5% fines (-3/16") from the aspen and 7.9% fines from the black poplar. The screen analysis using a Williams

Classifier is shown in Figure 13. Consistent to results obtained in Part I of this project, less fines are produced from aspen than black poplar.

The bulk density of the aspen strands was measured to be 60 kg/m^3 and 53 kg/m^3 for the black poplar. This is slightly different to measurements obtained in Part I (66 kg/m^3 for aspen and 48 kg/m^3 for black poplar). The difference here is in part due to the strands in Part II being screened to remove -3/16" fines.

The measurements of strand geometry are contained in Appendix C and summarized in Table 11. There were no significant differences in these measurements. The distribution of strand thickness for aspen and black poplar is shown in Figures 14 and 15 respectively. These distributions do not look much different.

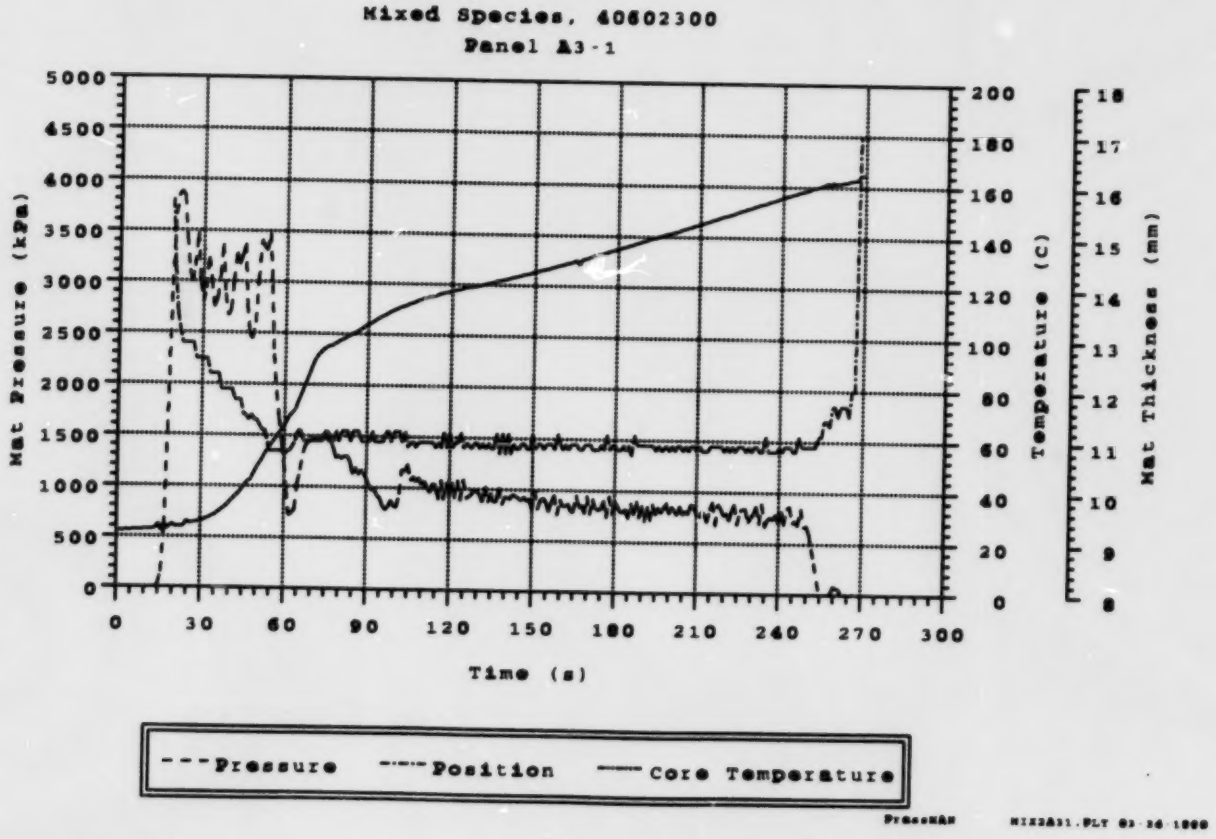

Figure 11 Sample pressing schedule for a panel made with aspen furnish.

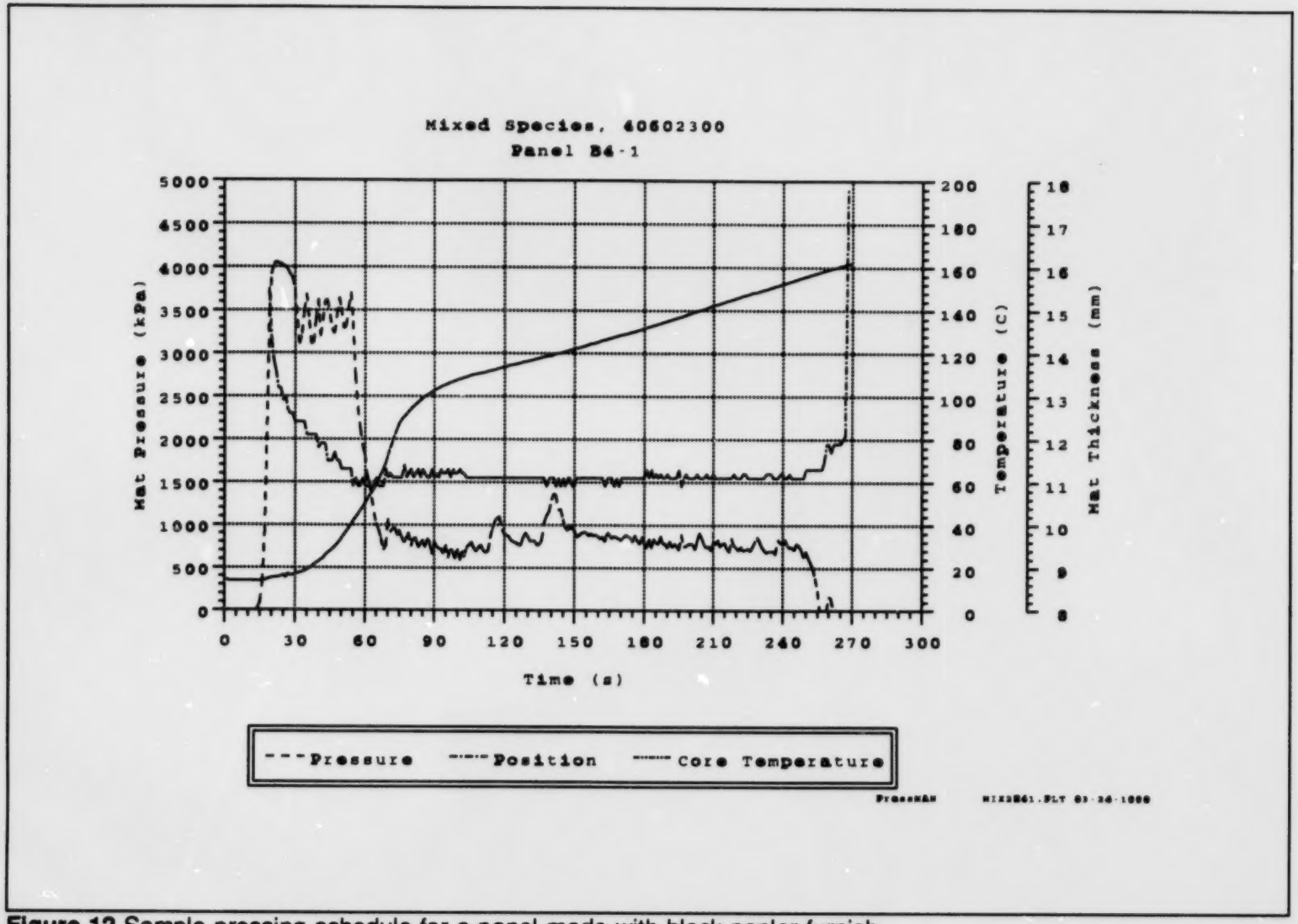

Figure 12 Sample pressing schedule for a panel made with black poplar furnish.

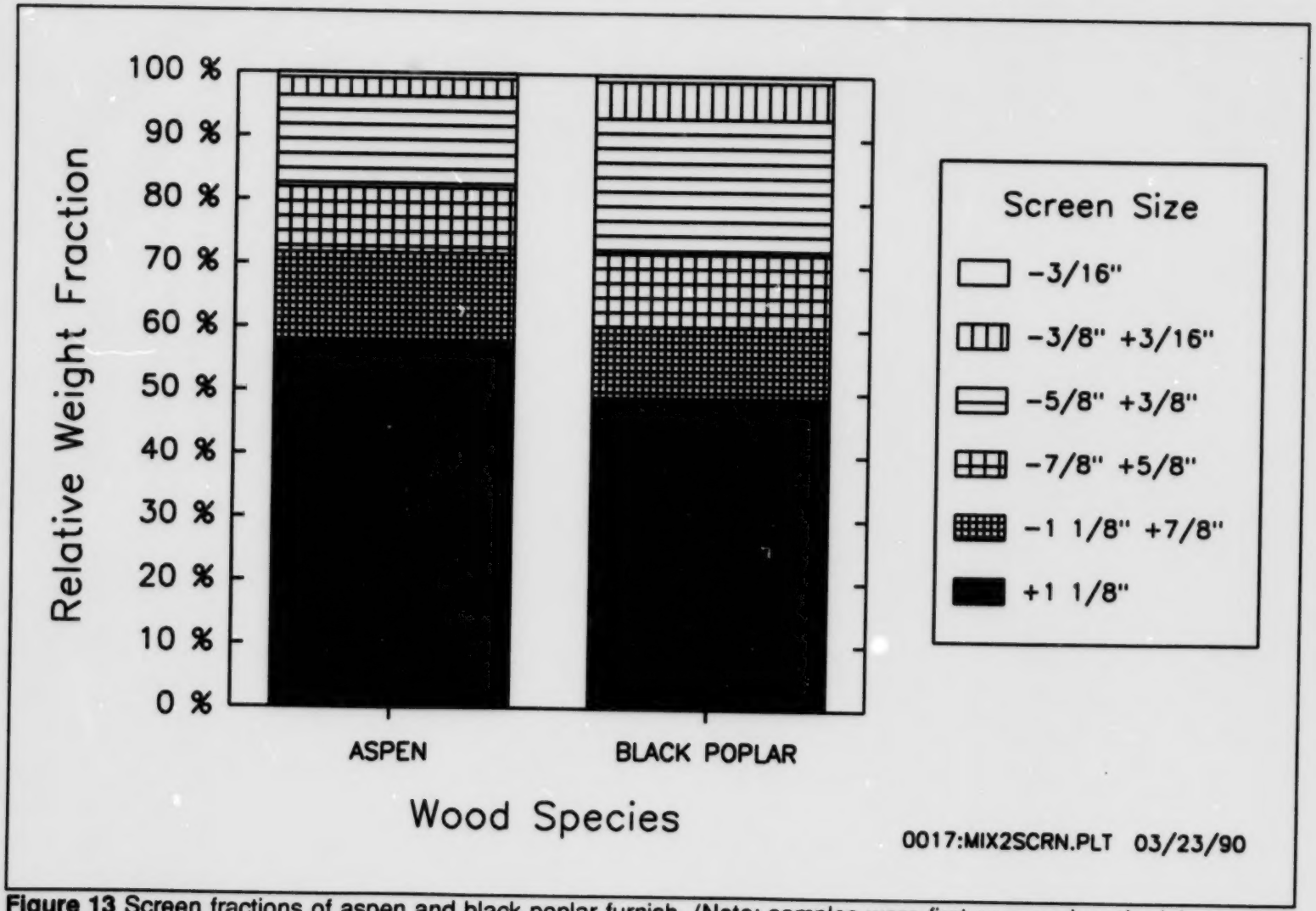

Figure 13 Screen fractions of aspen and black poplar furnish. (Note: samples were first screened on the lab screener to remove -3/16" fines).

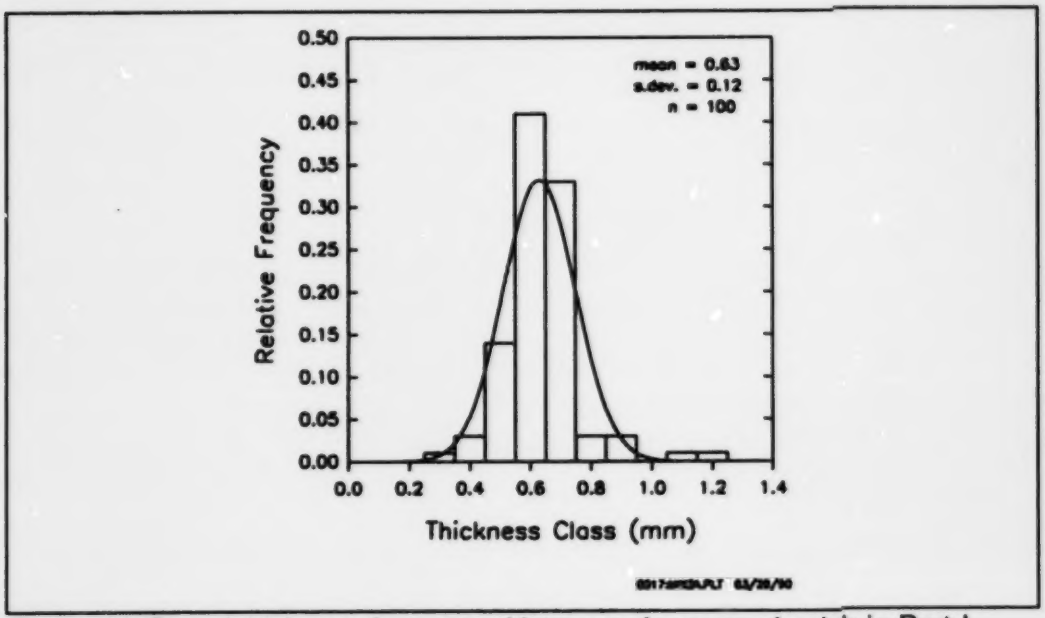

Figure 14 Strand thickness frequency histogram for aspen furnish in Part I.

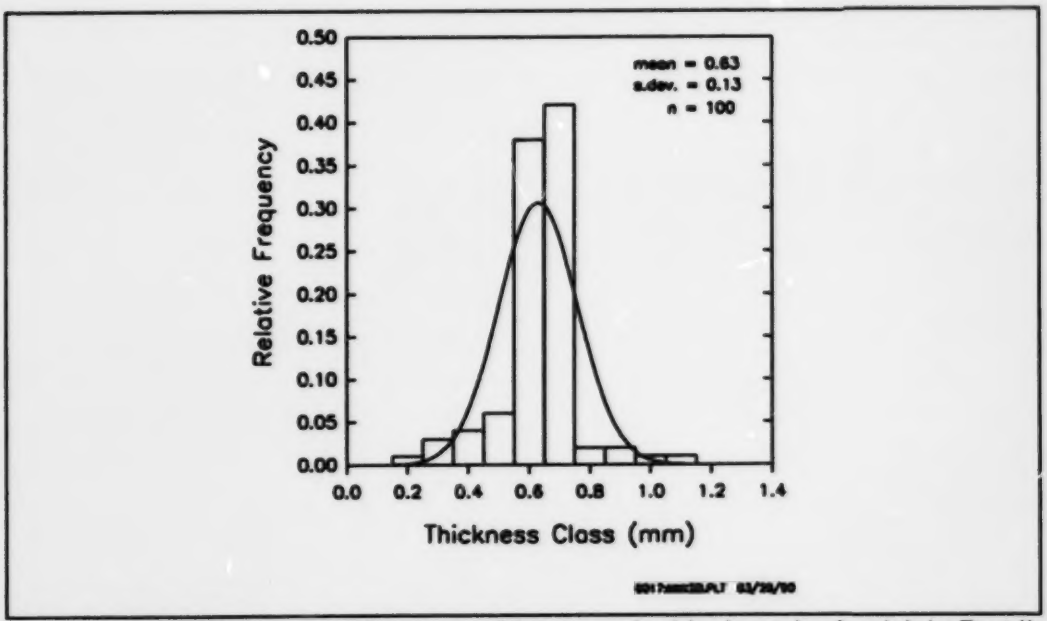

Figure 15 Strand thickness frequency histogram for black poplar furnish in Part II.

4.4.2 Panel Test Results

The test results of panels made in Part II of this project are contained in Appendix D. These results are summarized in Table 12 for the four aspen groups and in Table 13 for the four black poplar groups. Looking at each test separately:

a. Internal Bond: as seen in Figure 16, the drying temperature did seem to effect the internal bond of panels made of aspen, but not panels made of black poplar. The internal bond of panels made of aspen decreased with increased drying temperature. Black poplar groups exhibited no trends in terms of drying temperature.

   The internal bond of panels made of black poplar were significantly lower than those made of aspen. The difference was about 10%. However, the internal bond of all groups was well above CAN3-0437.0 requirements.

b. Modulus of Elasticity: similar to internal bond, drying temperatures seemed to affect the Modulus of Elasticity of aspen groups but not the black poplar groups. However, opposite to what was observed with internal bond, the MOE for aspen groups increased with increased drying temperature.

c. Modulus of Rupture: both the dry Modulus of Rupture (dry MOR) and the MOR after 2 hour boil (wet MOR) did not change significantly with drying temperature. Again however, aspen panels exhibited superior dry MOR and wet MOR over black poplar panels.

d. Thickness Swell: as shown in Figure 19, the thickness swell improved (was lower) with higher drying temperature. In this instance, the improvement was very small, however, as shown in previous work at ARC the thickness swell can be improved considerably if the strands are heat treated at higher temperatures (above 200°C) for prolonged periods.

   Again for all groups, the aspen panels were approximately 10% better in thickness swell compared to black poplar.

e. Linear Expansion: neither drying temperature nor wood species appeared to have an effect on the linear expansion of panels (see Figure 20).

Table 12. Summary table of grade properties for 11.1 mm thick aspen panels showing drying temperature effects.

	Units	Dir'n	CAN3-0437 R-1 Req.	Drying Temperature			
				50°C	100°C	125°C	150°C
Modulus of Rupture	MPa	Para. Perp. Avg.	17.2 17.2	31.3 34.0 32.7	28.8 37.0 32.9	30.1 35.6 32.9	32.2 34.5 33.4
Modulus of Elasticity	MPa	Para. Perp. Avg.	3100 3100	4300 4300 4300	4100 5100 4600	4100 4900 4500	4500 5000 4800
Internal Bond	MPa		0.345	0.806	0.749	0.748	0.664
Bond durability - MOR after 2 h boil	MPa	Para. Perp. Avg.	8.6 8.6	19.2 21.2 20.2	15.5 19.6 17.6	17.2 19.1 18.2	19.1 19.2 19.2
Thickness Swell - 24 h soak - 12.7 mm or thinner	%		25	18	17	16	14
Linear Expansion - oven dry to saturated	%	Para. Perp. Avg.	0.40 0.40	0.30 0.26 0.28	0.30 0.25 0.28	0.28 0.26 0.27	0.29 0.25 0.27
Panel density for 12 pt. thickness	kg/m^3		Not a CAN3-0437 test	647	641	644	644

Table 13. Summary table of grade properties for 11.1 mm thick black poplar panels showing drying temperature effects.

	Units	Dir'n	CAN3-0437 R-1 Req.	Drying Temperature			
				50°C	100°C	125°C	150°C
Modulus of Rupture	MPa	Para. Perp. Avg.	17.2 17.2	29.5 32.4 31.0	27.1 29.7 28.4	25.6 31.2 28.4	27.5 30.7 29.1
Modulus of Elasticity	MPa	Para. Perp. Avg.	3100 3100	4100 4500 4300	4100 4400 4300	3900 4500 4200	4100 4300 4200
Internal Bond	MPa		0.345	0.679	0.596	0.649	0.665
Bond durability - MOR after 2 h boil	MPa	Para. Perp. Avg.	8.6 8.6	14.5 16.9 15.7	14.1 17.3 15.7	13.8 18.0 15.9	12.9 14.3 13.6
Thickness Swell - 24 h soak - 12.7 mm or thinner	%		25	19	19	19	16
Linear Expansion - oven dry to saturated	%	Para. Perp. Avg.	0.40 0.40	0.25 0.30 0.28	0.30 0.27 0.29	0.26 0.25 0.26	0.30 0.31 0.31
Panel density for 12 pt. thickness	kg/m^3		Not a CAN3-0437 test	649	638	644	648

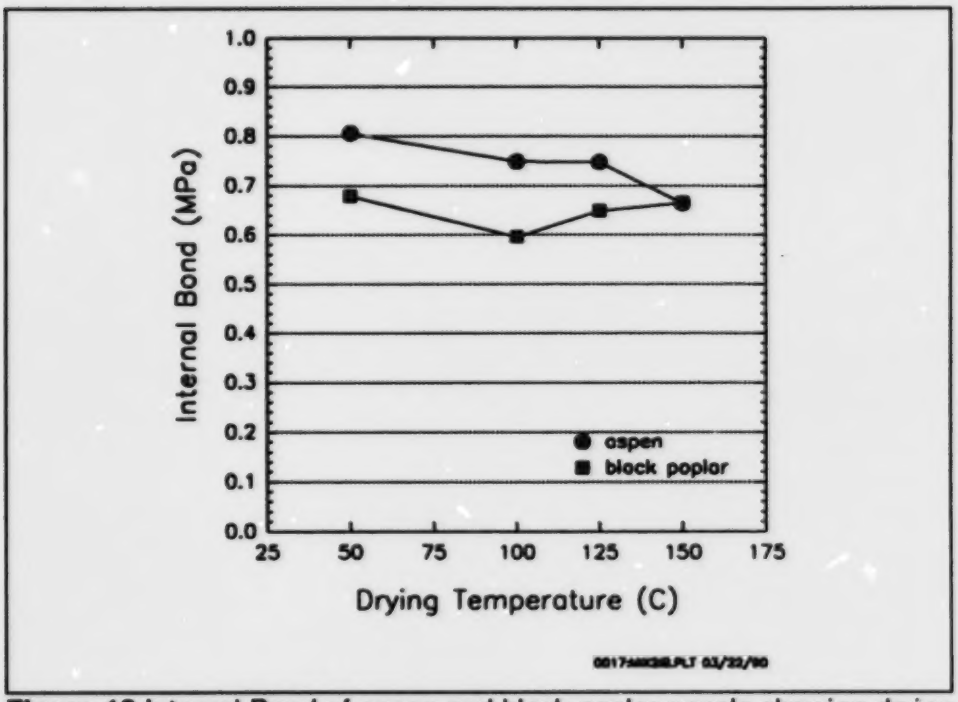

Figure 16 Internal Bond of aspen and black poplar panels showing drying temperature effects.

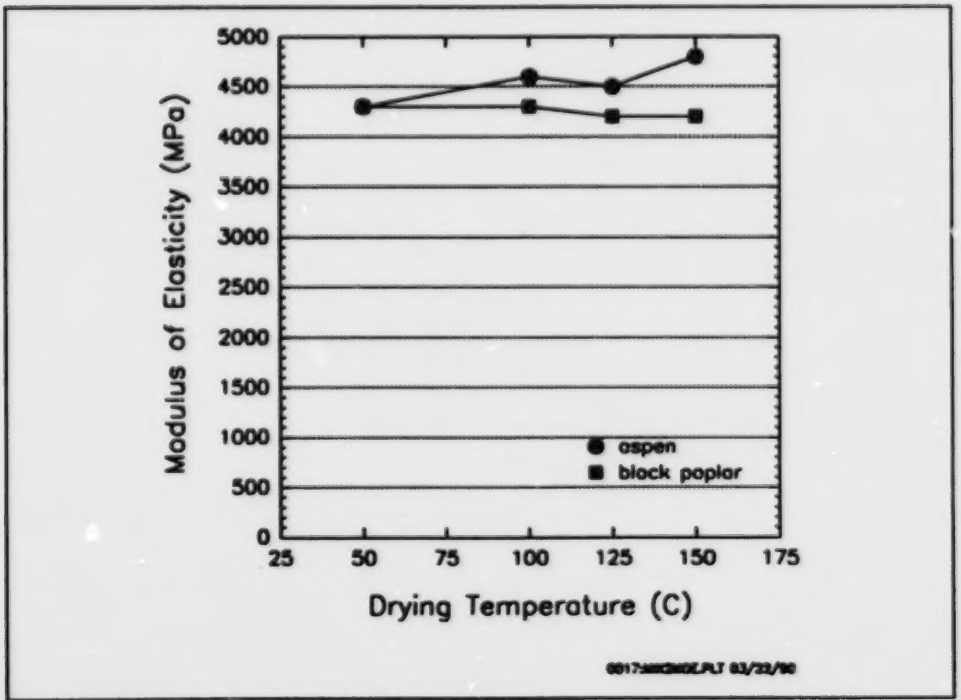

Figure 17 Modulus of Elasticity of aspen and black poplar panels showing drying temperature effects.

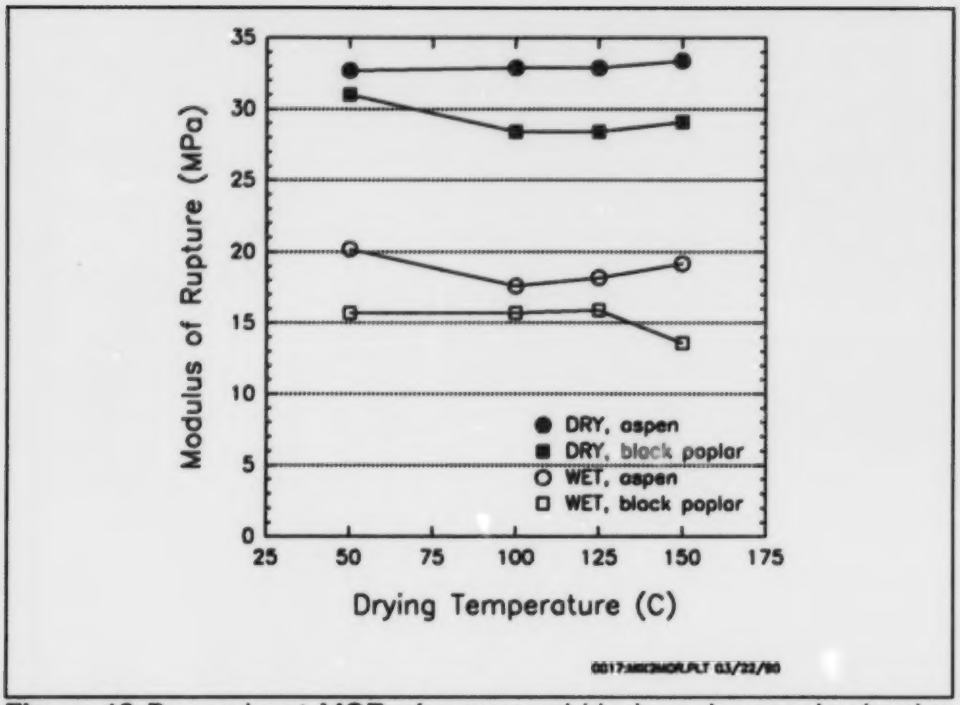

Figure 18 Dry and wet MOR of aspen and black poplar panels showing drying temperature effects.

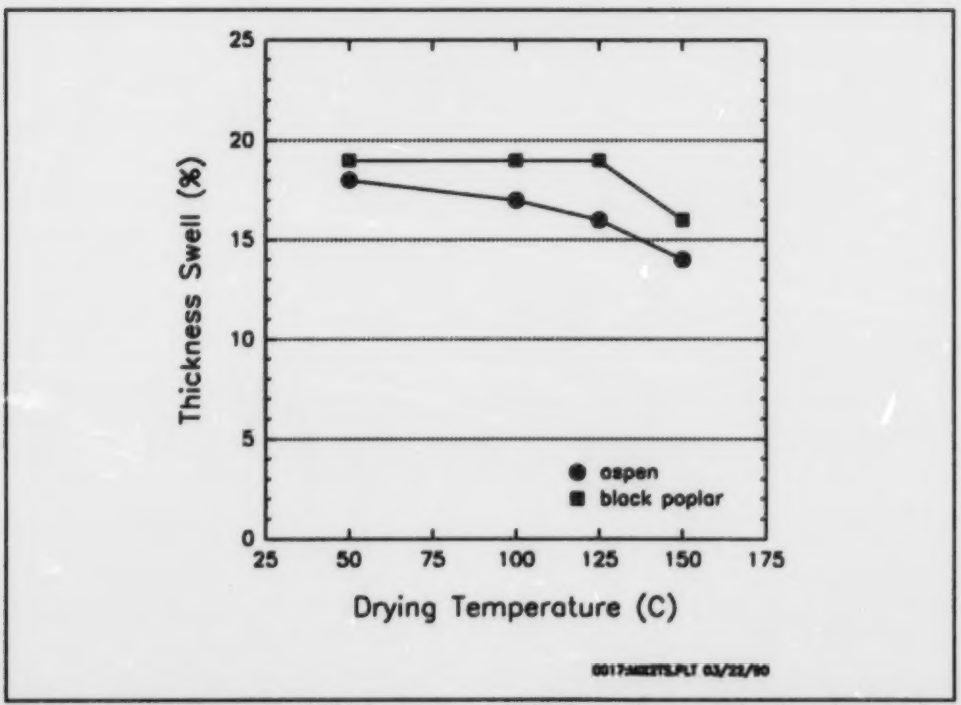

Figure 19 Thickness swell of aspen and black poplar panels showing drying temperature effects

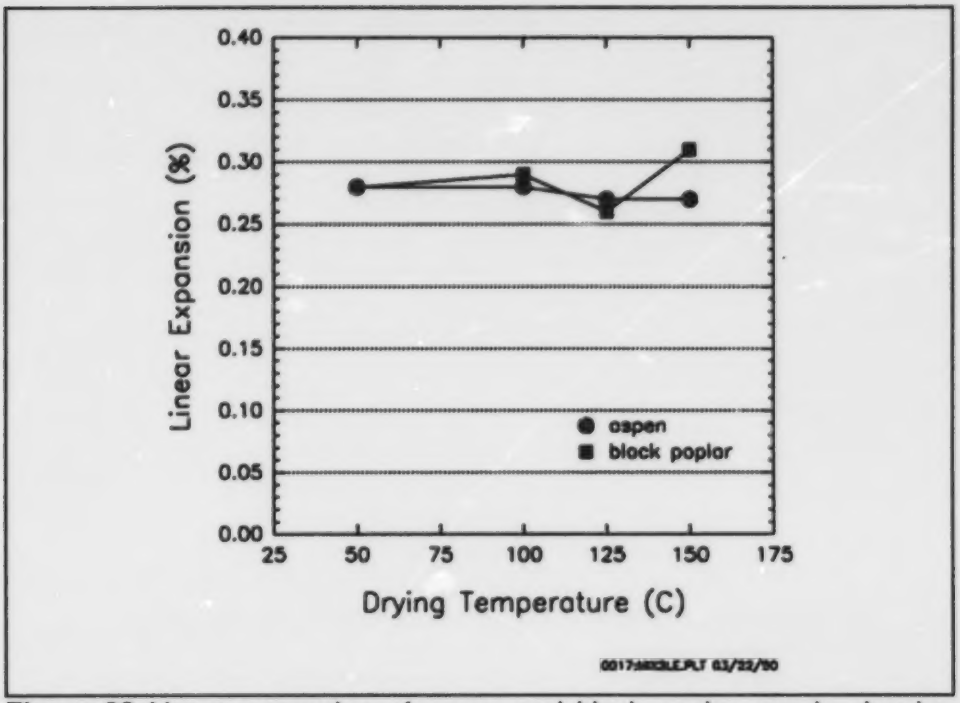

Figure 20 Linear expansion of aspen and black poplar panels showing drying temperature effects.

4.5 Conclusions

From drying aspen and black poplar at four temperature levels, and subsequent production of panels it can be concluded that:

1. The only panel property lessened by increased drying temperature was internal bond, and this was only evident for aspen and not black poplar.

2. Thickness swell was lowered for aspen and black poplar made of furnish dried at higher temperatures.

3. The properties of aspen panels are approximately 10% better than black poplar panels produced under similar conditions.

5. PART III - PILOT PLANT AND MILL TRIAL

5.1 Objectives and Goals

The objective of this part of the project was to carry out a mill trial based on previous results and all other available knowledge.

5.2 Introduction

In cooperation with Weldwood of Canada Limited a mill trial with black poplar was attempted in a previous (1987/88) Mixed Species project. In that trial, the production of 100% black poplar panels was tried. A major difficulty encountered in that trial was drying the black poplar to a useable moisture content. As a result of this problem and because of the limited material available for the trial, only a couple of pressloads could be produced and, of these, the pressing times were too short to give adequate cure of the resin. The pressing times were shorter for the black poplar panels compared to the aspen panels because of the easier compaction of the black poplar which automatically reduced the cycle times in the Weldwood press control programme.

From the knowledge gained in the 1987/88 mill trial, and from the results of the first two parts of this project, a mill trail was arranged for this project.

Weldwood of Canada Limited were again contacted to participate in this trial. Weldwood agreed to a small trial of roughly the same magnitude as the previous trial. In addition, Weldwood helped set up the production parameters for the trial.

Previous to the mill trial, ARC produced a number of 1220 mm x 2440 mm panels at their pilot plant of similar production parameters as the trial panels. Following are the results of the pilot plant and mill trial.

5.3 Methods and Materials

5.3.1 Pilot Plant Trial

The technical department of Weldwood of Canada Limited were contacted for input in determining an experimental design and production specification for both the pilot plant and mill trial. It was decided to make the following groups of panels in the pilot plant trial:

Group A: aspen in face and core

Group AB: 50/50 aspen/black poplar in face and aspen in core

Group B: black poplar in face and aspen in core

Except for the different furnish, the production specifications for all panels was as shown in Table 14.

Table 14. Panel Specifications for 11.1 mm OSB made in the Pilot Plant.

face furnish	(1) aspen - prepared at ARC - 0.64 mm thick, 75 mm long nominal - 8.0% moisture content (2) black poplar - prepared at ARC - 0.64 mm thick, 75 mm long nominal - 8.5% moisture content
core furnish	- aspen strand - 0.64 mm thick, 75 mm long nominal - 4.1% moisture content - prepared by commercial OSB mill
face resin	- Reichhold BD-802 phenolic powder - 2% weight content
core resin	- Borden W3154N phenolic powder - 2 % weight content
face and core wax	- hot slack wax - 1.0% weight content
target density	- 640 kg/m^3 (40 lb/ft^3)
target thickness	- 11.1 mm (7/16 in.)
mat dimensions	- 1470 mm x 2690 mm (58 in. x 106 in.)
panel dimensions	- 1220 mm x 2440 mm (4 ft. x 8 ft.)
panel construction	- three layer oriented (OSB) - machine direction orientation in face - cross direction orientation in core - 60/40 face/core ratio
platen temperature	- 205°C (400°F)
pressing time	- 220 s

Aspen and black poplar furnish used in the face of the panels was waferized at ARC. The preparation of both these furnishes was done at the same time as the furnish for Part II of this project. The preparation procedure and furnish analysis is contained in Part II of this report.

The aspen furnish used in the core of all the panels was obtained from a commercial mill.

The remaining panel specifications were chosen to closely simulate the process at the Weldwood OSB mill in Slave Lake, Alberta at the time of the trial. A 2% resin content and a 1% wax content were used for both the face and core furnish. These were applied in the pilot plant's 1220 mm deep x 2440 mm diameter drum blender.

Mats were formed on the pilot plant's mechanical former. The mats were made in four passes, one for each face and two for the core. The strands were oriented in the machine direction in the faces and in the cross direction in the core of the mats. A 60:40 face to core ratio was used.

The panels were pressed in the 4' x 8' hydraulic hot press. A pressing schedule was programmed to give constant panels thickness and density. A 60 second closing time was used in a 220 second total cycle. Plots of mat pressure, thickness and core temperature are shown in Figures 21 to 23 for Groups A, AB and B respectively.

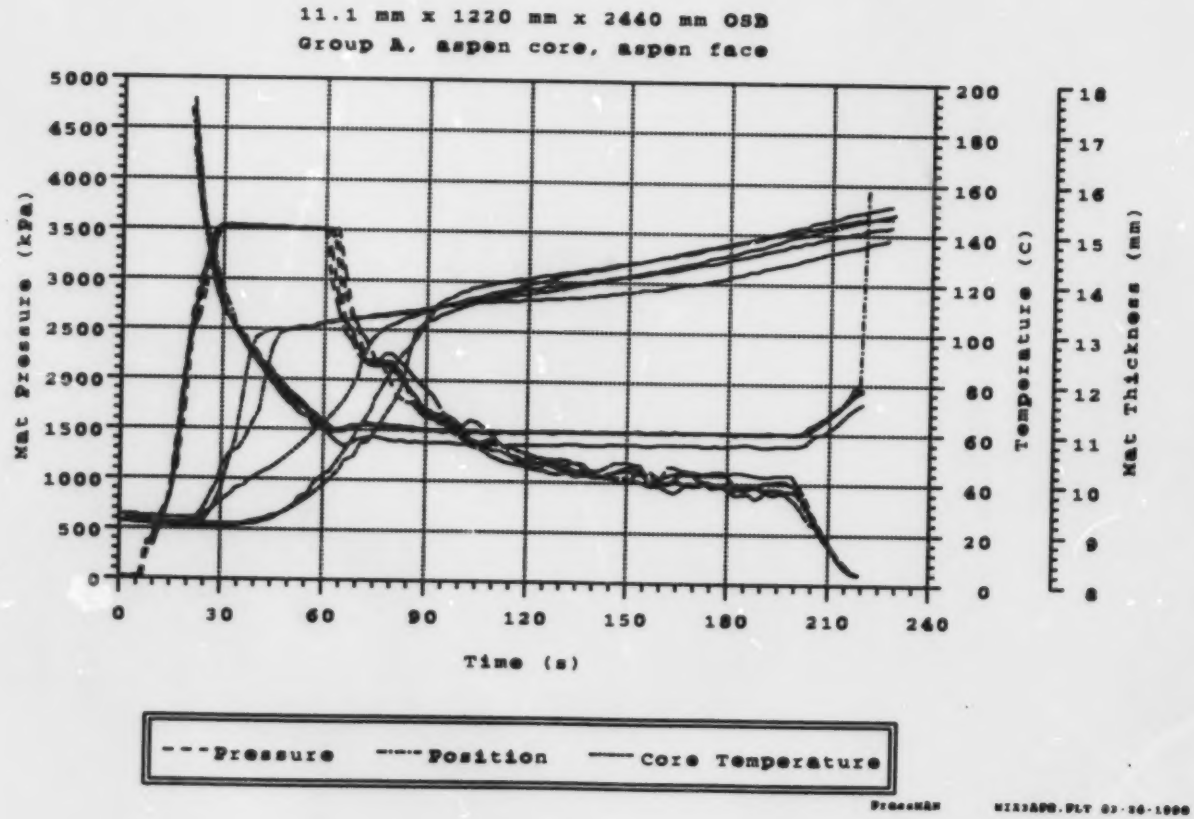

Figure 21 Press cycle overlays of OSB made in the Pilot Plant with aspen in face.

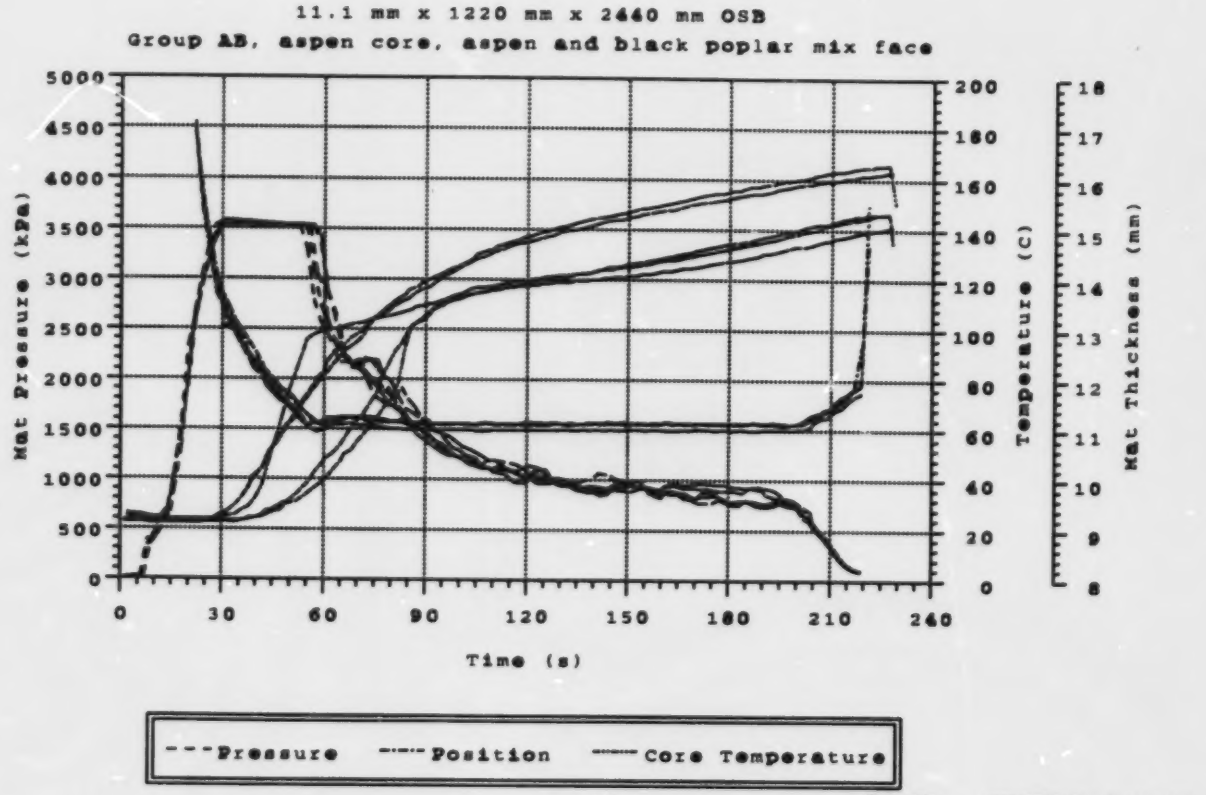

Figure 22 Press cycle overlays of OSB made in the Pilot Plant with mix of aspen and black poplar in face.

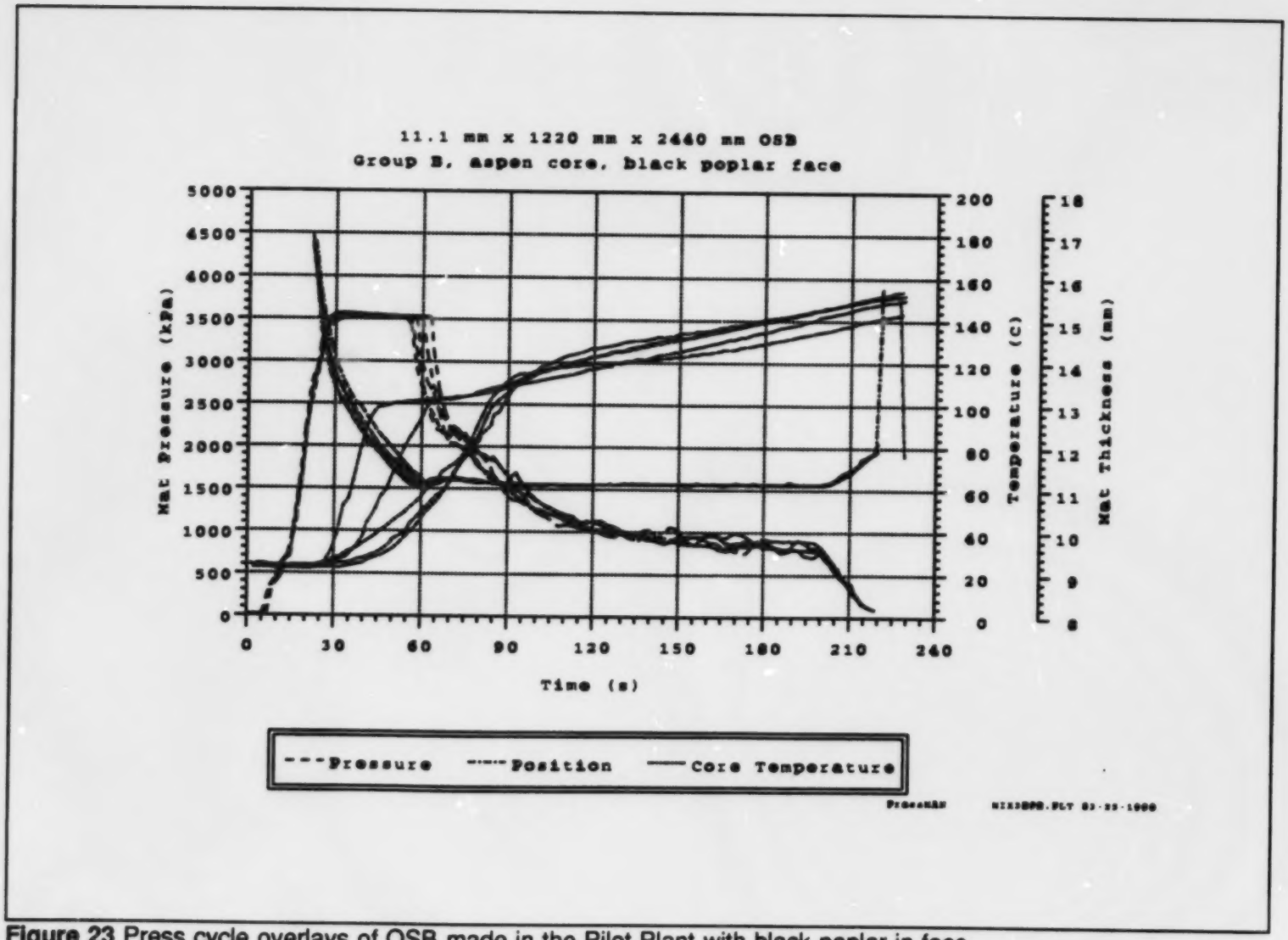

Figure 23 Press cycle overlays of OSB made in the Pilot Plant with black poplar in face.

5.3.2 Mill Trial

A mill trial was arranged with Weldwood of Canada Limited, Slave Lake OSB mill for March 1, 1990. For the mill trial, panels with aspen in the core and black poplar in the face (similar to Group B panels made in the pilot plant) were scheduled to be made.

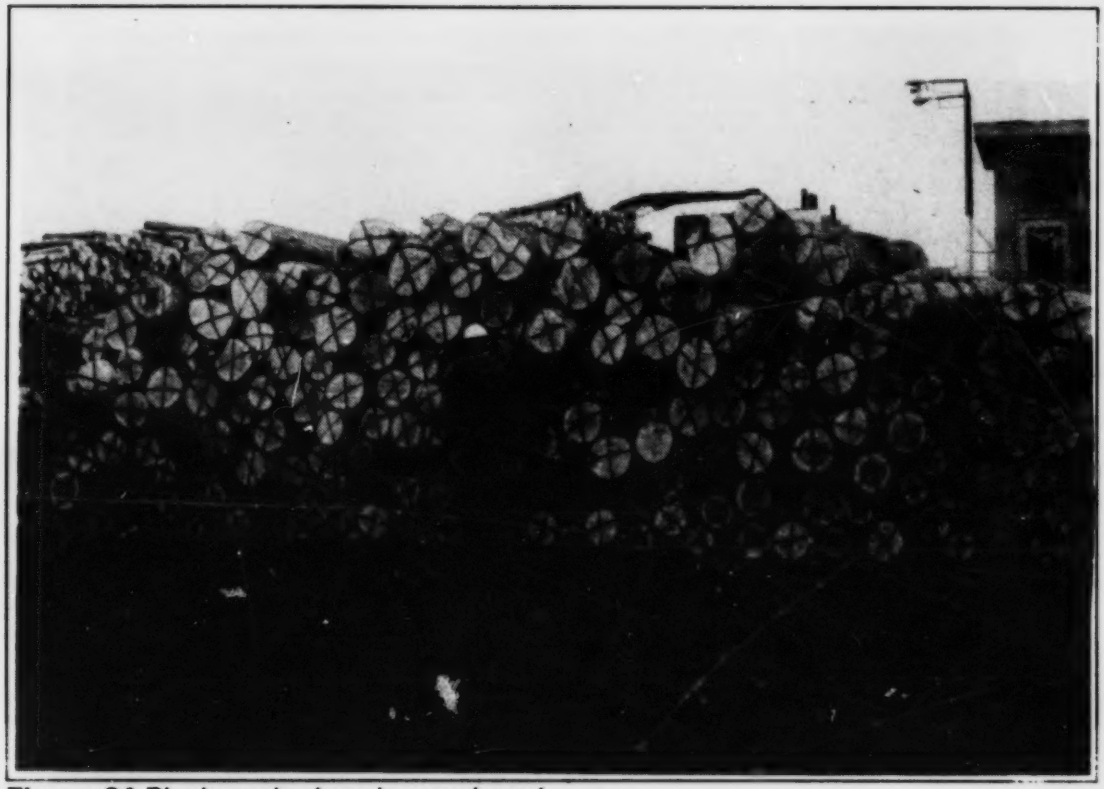

Figure 24 Black poplar logs in wood yard.

Trees of black poplar were harvested approximately two weeks prior to the mill trial from an active logging site near the mill. A picture of the black poplar logs in the wood yard is shown in Figure 24.

The logs of black poplar were placed in a heated log pond (approximately 40°C) shortly after midnight. In the morning, at approximately 8:00 AM and at the start of the mills regular maintenance shut-down, the mill began waferizing the black poplar logs. The temperature of the logs appeared to vary anywhere between 0 and 30°C depending on the percent of rot in the wood and location of measurement. The temperature of the logs did not, however, appear to be significantly different from the regular run of aspen.

Two CAE Machinery Ltd. Model 93 disc waferizers were used to waferize the black poplar. The waferizer was set to produce 0.68 mm (0.027 in.) thick

by 75 mm (3 in.) long strands. The cutting knives were ground to a 27° wedge angle. Counter knives with a 65° wedge angle were used and no reactor knives were used. The knives of the waferizers had approximately 0.5 and 4 hours of operation on them prior to the start of the black poplar run. It took approximately one hour to waferize all the black poplar on the two waferizers.

Samples of aspen and black poplar strands were collected from the waferizer for analysis. The aspen was collected prior to the changeover to black poplar. Core aspen furnish and face black poplar furnish was also collected for analysis after it had been dried and screened in the mill.

The black poplar was dried in the face dryer. Because of the higher moisture content of the black poplar, 150% MC compared to 100% MC for aspen, the dryer had difficulty in stabilizing the outlet dryer temperature and thus the moisture content. However, due to knowledge gained from the first mill trial, the difficulty was quickly rectified by augmenting the wood burners with approximately 20% gas and adjusting the through-put to increase the dwell time in the dryer. The moisture content was stabilized at approximately 8%.

All the black poplar furnish was dried and screened to remove -3/16" fines during maintenance shut-down and stored in the face surge bin. On start-up at approximately 4:00 PM, the core surge bin was filled with aspen and the face surge bin was filled with black poplar. The aspen core furnish had been processed as in regular production and similar to the black poplar face furnish except that it was dried to approximately 5% moisture content and -1/8" fines were removed at screening.

The production specifications for the trial panels are shown in Table 15.

Table 15. Panel specifications for OSB made during the mill trial.

face furnish	- black poplar
core furnish	- aspen
face resin	- Reichhold BD-802 phenolic powder - 2% weight content
core resin	- Borden W3154N phenolic powder - 2% weight content
face and core wax	- hot slack wax - 1% weight content
target density	- 640 kg/m^3 (40 lb/ft^3)
target thickness	- 11.1 mm (7/16")
panel construction	- three layer oriented (OSB) - machine direction orientation in face - cross direction orientation in core - 60/40 face/core ratio (target)
platen temperature	- 205°C (400°F) at surface (218°C steam temperature)
pressing time	- 220 seconds for press loads which where tested

There was little observed difference in blending the black poplar furnish as compared to a regular run of aspen. Normal rates (2% resin and 1% wax) of resin and wax additions were used.

Figure 25 ARC technologist inserting thermocouple into mat.

Major difficulties in production were encountered in forming the black poplar mats. A lower bulk density for the black poplar was anticipated and the belt speeds on the face forming bin were increased to compensate for approximately a 10% difference in bulk density. However, the first few pressloads showed this was not enough, and thus the line speed was gradually increased in an attempt to place more material onto the mat. Because of the lag time in measuring panel densities (up to two press loads) and because of the shortness of the trial, the mill was never able to increase the mat weight enough to get target density.

A total of 14 pressloads were pressed on the mill's 24 opening, 4' x 16' press. As previously explained, the mat weight was low for all the press loads. Because of the pressing strategy employed in this mill, the pressing times were automatically decreased and inadequate cure could be seen in some of the

pressloads. The pressing cycle was adjusted such that the last few pressloads had adequate time in the press even though the mat was still slightly light.

Measurements of core temperature were made by ARC (see Figure 25). Figure 26 shows the variability in pressing time and temperature of the black poplar trial panels. Similar readings (Figure 27) taken after the trial on regular production show considerably less variability.

The 14 pressloads made with black poplar in the face were separated by pressload and stored in the corner of the warehouse (see Figure 28). After approximately 12 hours, panels were removed from stack of pressloads 12 and 13 for testing. These pressloads had panels of higher density and the pressing times similar to regular production.

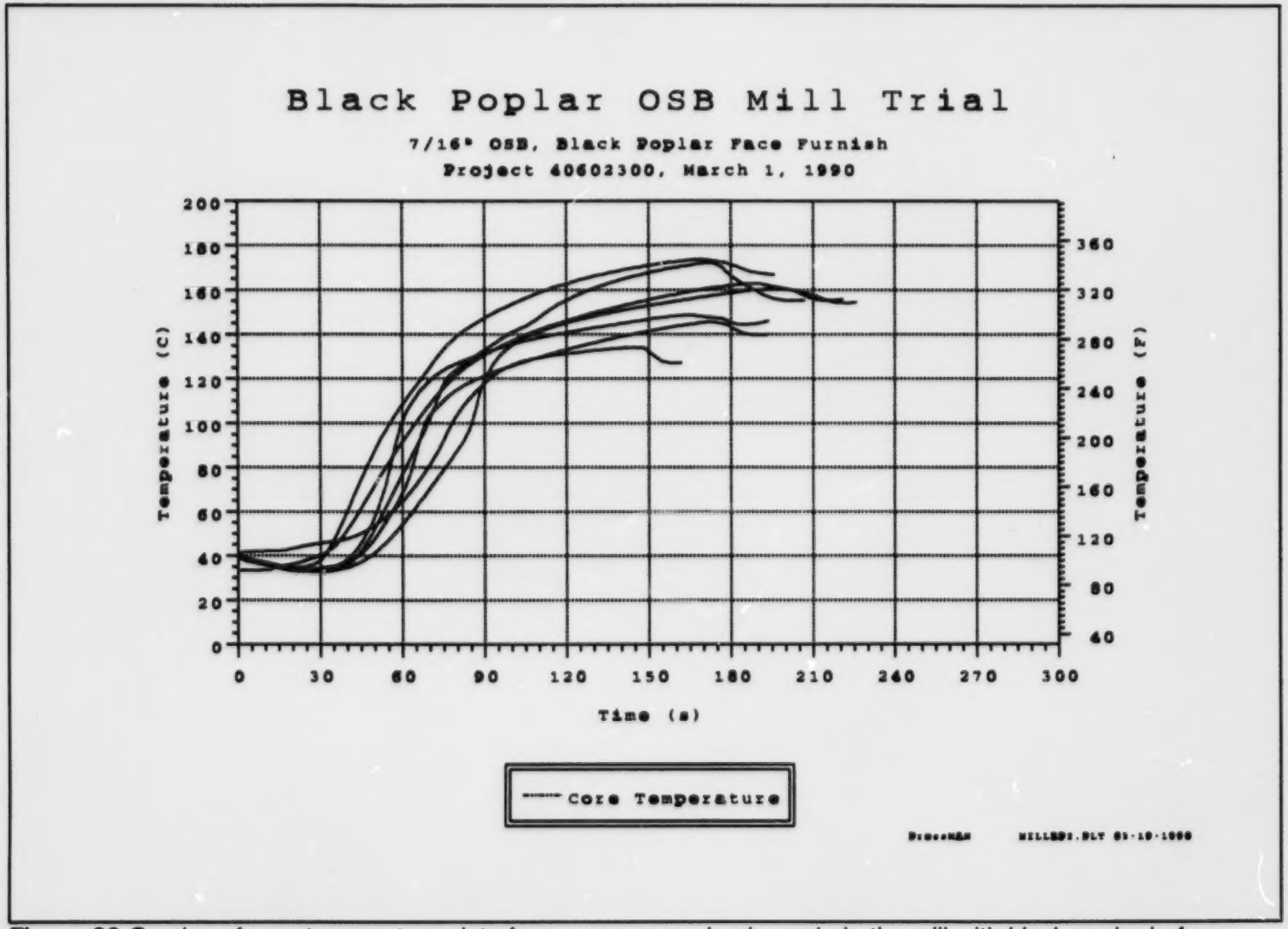

Figure 26 Overlay of core temperature plots from seven press loads made in the mill with black poplar in face.

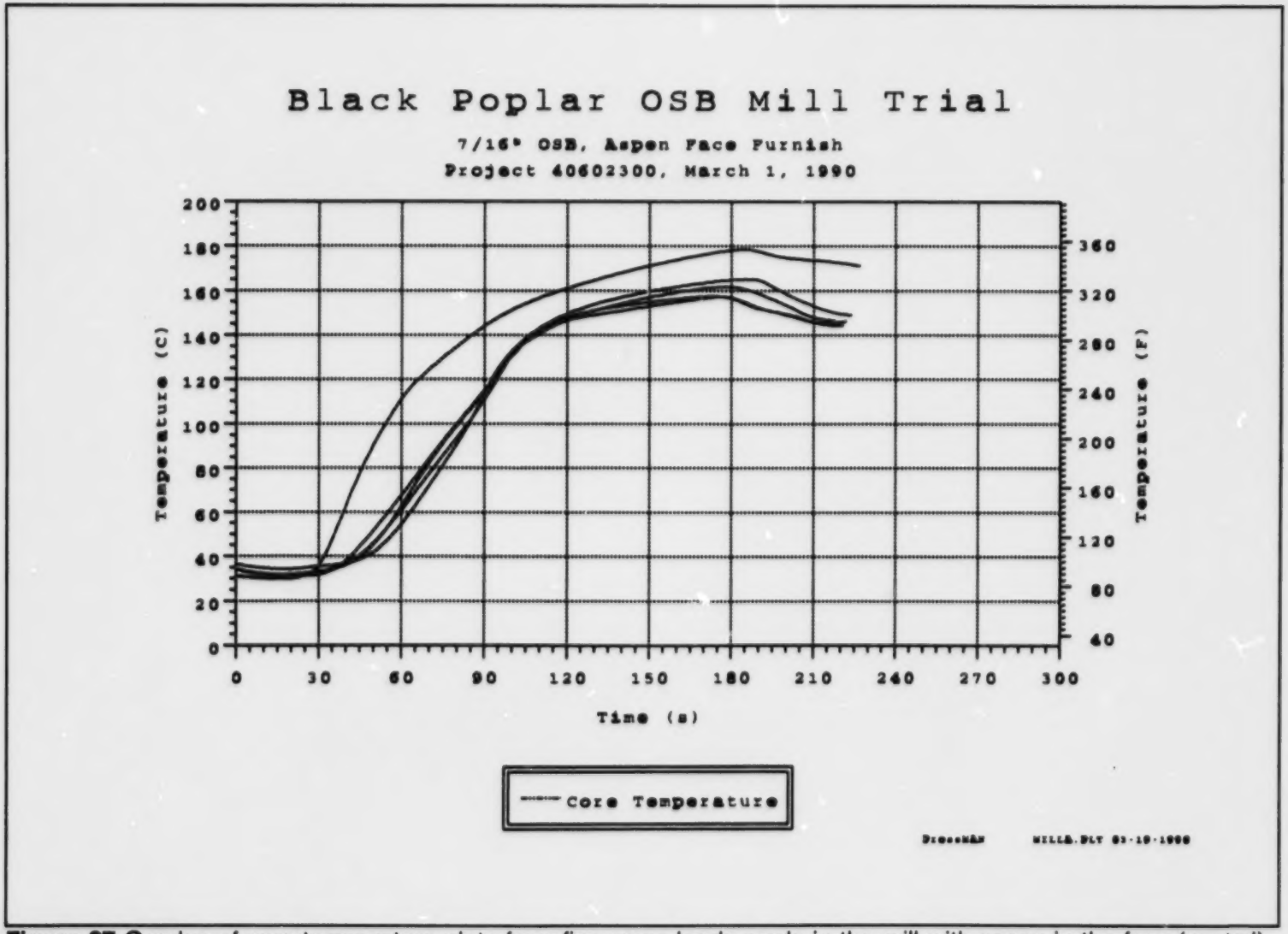

Figure 27 Overlay of core temperature plots from five press loads made in the mill with aspen in the face (control).

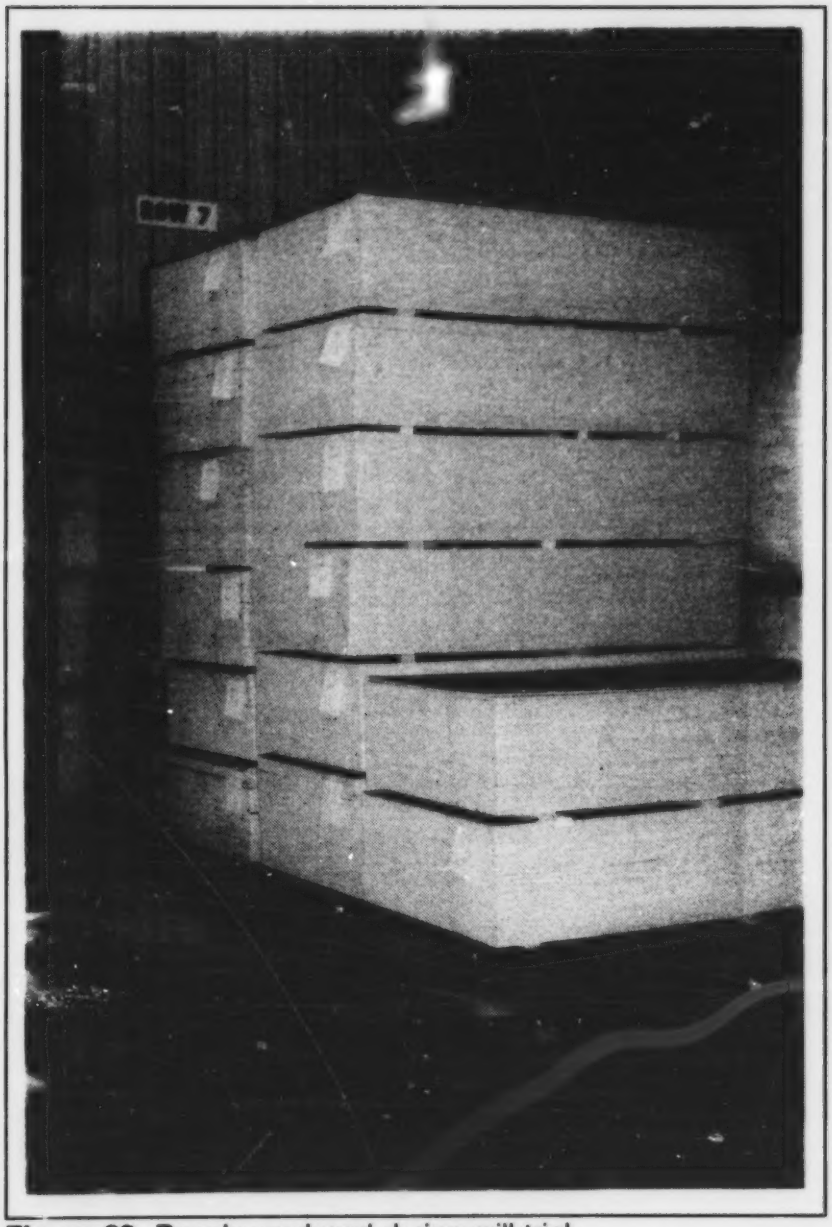

Figure 28 Panels produced during mill trial.

5.4 Results and Discussion

5.4.1 Analysis of Strands Collected from Mill Trial

Figure 29 shows the screen fractions measured with the Williams Classifier for the furnish collected at the mill. There was not much of a difference in screen fractions between aspen and black poplar collected prior to drying and screening. However, it was surprising that the aspen core furnish would have less fine material than the black poplar face material, since the face was screened to remove -3/16" fines and the core was screened to remove -1/8" fines.

The bulk density of the strands collected prior to drying and screening were 45 kg/m^3 for the aspen and 32 kg/m^3 for the black poplar. This is about a 30% difference in bulk densities of the two species. The bulk density of the aspen core furnish was measured to be 72 kg/m^3 compared with 55kg/m^3 for the black poplar face furnish. This is about a 25% difference between the two species.

The strand geometry measurements for the different samples collected is shown in Appendix E. Figures 30 to 33 show the strand thickness frequency distributions. There did not seem to be a significant difference between the two species in the flake geometry measurements. In comparing these thickness measurements to measurements of strands made in the pilot plant, the thickness of strands made in the pilot plant have a smaller variance (0.12 mm standard deviation) than the strands made in the mill (0.20 mm standard deviation).

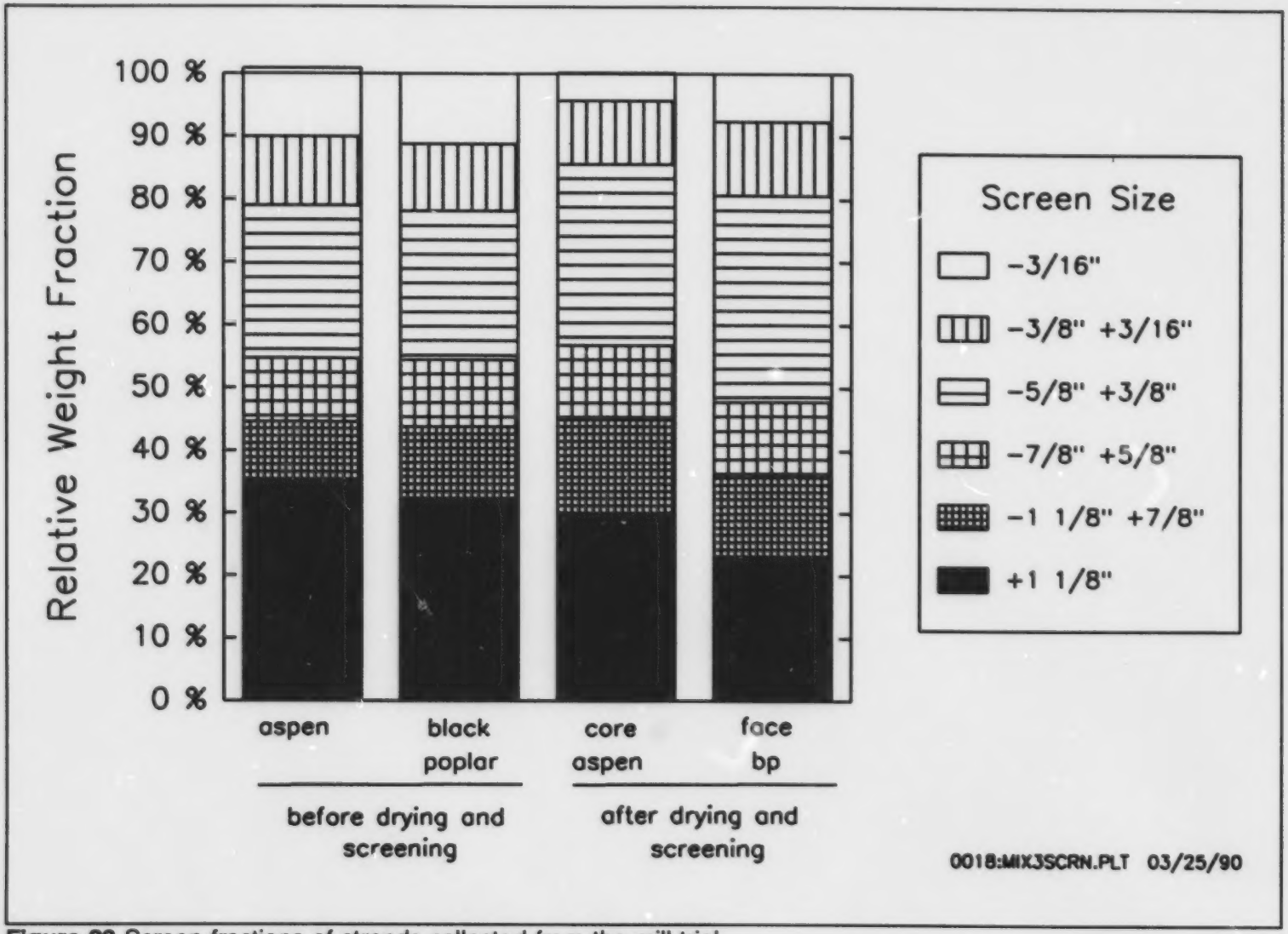

Figure 29 Screen fractions of strands collected from the mill trial.

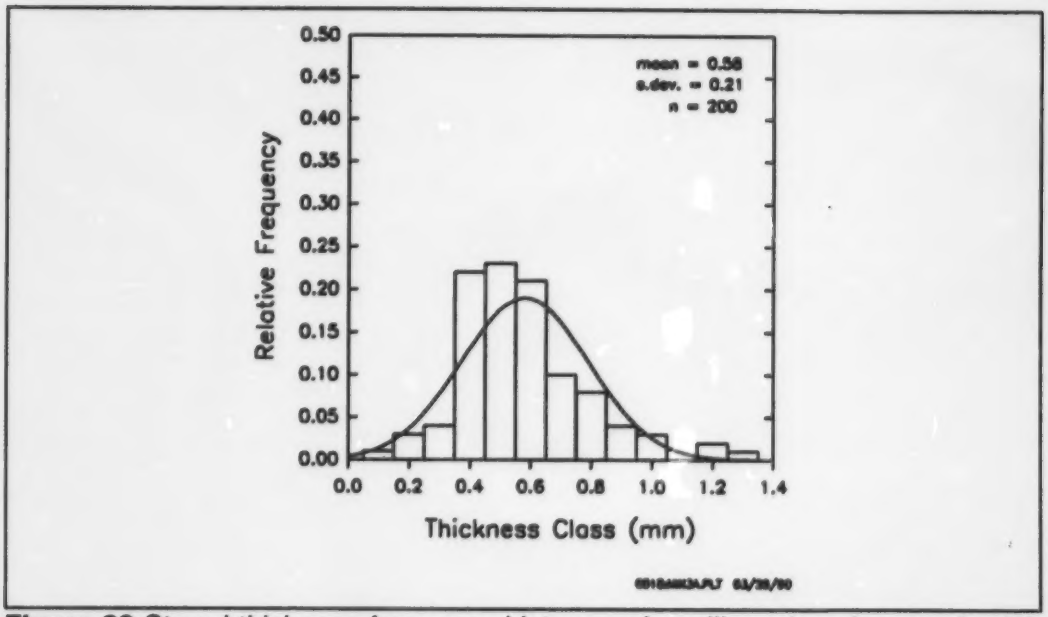

Figure 30 Strand thickness frequency histogram for mill produced aspen furnish collected prior to drying and screening.

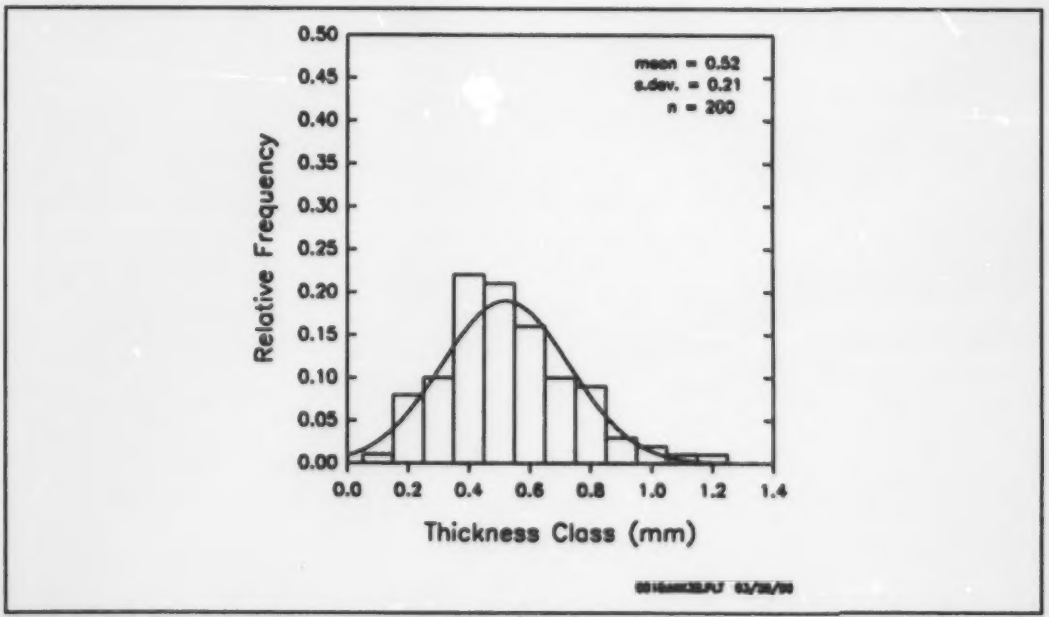

Figure 31 Strand thickness frequency histogram for mill produced black poplar furnish collected prior to drying and screening.

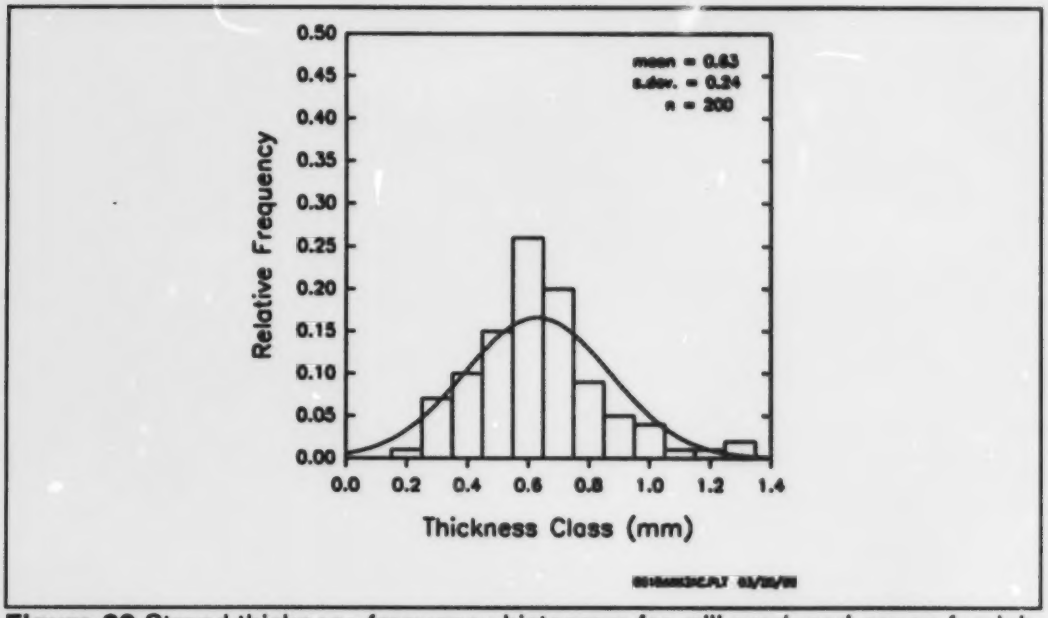

Figure 32 Strand thickness frequency histogram for mill produced aspen furnish, dried and screened core material.

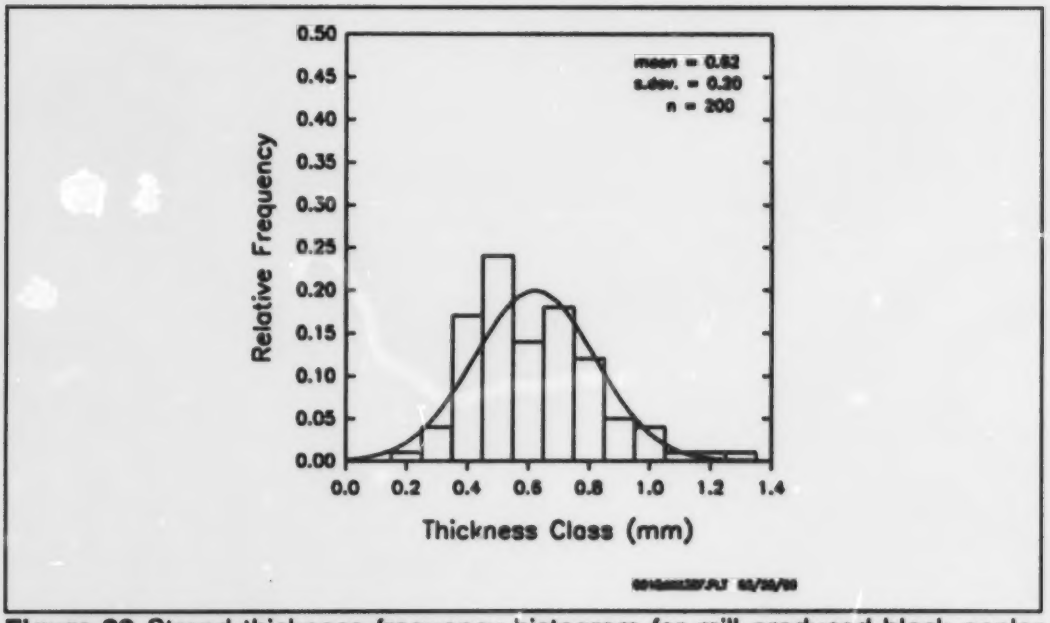

Figure 33 Strand thickness frequency histogram for mill produced black poplar furnish, dried and screened face material.

5.4.2 Panel Test Results from Pilot Plant and Mill Trials

The test results of panels made in the pilot plant are contained in Appendix F and the mill trial results are contained in Appendix G. These results are summarized in Table 16 and Table 17 respectively. As previously mentioned, the density of panels with black poplar in the face made during the mill trial was significantly lower than the control panels made in the pilot plant. As such, a direct comparison between these groups cannot be made. However, considering the density differences, the properties of these panels are not way out of line to the control panels.

Looking at each test individually:

a. Internal Bond: as can be seen from Figure 34, the internal bond of panels made in the pilot plant was slightly higher than the internal bond of panels made in the mill. The internal bond of the panels produced in the pilot plant show black poplar to have an effect on internal bond. The internal bond of 100% aspen panels was about 10% higher than that of panels using black poplar in the face. However, there was no correlation between the fraction of black poplar used and the internal bond properties.

   All panels tested, including the low density mill trial black poplar panels, exceeded the CAN3-0437.0-M85 requirements for internal bond.

b. Modulus of Elasticity: as can be seen from Figure 35 there was no apparent difference in the Modulus of Elasticity of OSB made in the pilot plant.

   All groups, except for press load #13 from the mill trial, exceeded CAN3-0437 0-2 requirements.

c. Modulus of Rupture: the Modulus of Rupture (see Figure 36) of panels made of 100% aspen in the pilot plant had slightly higher MOR than the other two groups made in the pilot plant with black poplar in the face. There was a considerable difference between MOR of panels made in the pilot plant compared to those from the mill. This difference could be attributed to differences in construction (face to core ratio) and strand alignment. The pilot plant panels had higher MOR in the parallel direction, but slightly lower MOR in the perpendicular direction as compared to the mill produced panels.

Both press loads with black poplar in the face made in the mill trial failed to meet CAN3-0437 0-2 requirements for MOR in the parallel direction.

d. Bond Durability: the Modulus of Rupture after 2 hour boil was about 50% of the dry MOR for all groups.

e. Thickness Swell: as can be seen from Figure 38, the thickness swell did not seem to be affected by species mix for panels made in the pilot plant.

All panels tested exceeded the CAN3-0437 requirements for thickness swell.

f. Linear Expansion: the small differences in linear expansion seem only due to panel construction and flake alignment, and not species mix. The mill trial panels had lower linear expansion than those made in the pilot plant.

Table 16. Summary table of grade properties for 11.1 mm OSB produced in the Pilot Plant.

	Units	Dir'n	CAN3-0437 0-2 Req.	Aspen Face	Aspen/ black poplar face	Black poplar face
Modulus of Rupture	MPa	Para Perp	29.0 12.4	45.3 17.0	39.1 17.0	42.1 16.9
Modulus of elasticity	MPa	Para Perp	5500 1500	7400 2100	7100 2300	7300 2100
Internal bond	MPa	N/A	0.345	0.481	0.430	0.440
Bond durability - MOR after 2 h boil	MPa	Para Perp	14.5 6.2	21.8 8.7	20.0 9.8	21.5 8.7
Thickness swell -24 h soak	%	N/A	25	15	16	15
Linear expansion - oven dry to saturated	%	Para Perp	0.40 0.40	0.20 0.40	0.22 0.38	0.25 0.37
Moisture content	%	N/A	Max. 8.0	3.0	3.0	3.0
Density from 12 pt thickness	kg/m^3		Not a CAN3-0437 test	636	639	644

Table 17. Summary table of grade properties for 11.1 mm OSB produced in the mill trial.

	Units	Dir'n	CAN3-0437 0-2 Req.	Aspen Face	Black poplar face load #12	Black poplar face load #13
Modulus of Rupture	MPa MPa	Para Perp	29.0 12.4	30.7 19.1	25.7 17.7	25.7 18.6
Modulus of elasticity	MPa MPa	Para Perp	5500 1500	6600 2600	5600 2300	5400 2400
Internal bond	MPa	N/A	0.345	0.414	0.397	0.364
Bond durability - MOR after 2 h boil	MPa MPa	Para Perp	14.5 6.2	16.0 10.9	14.7 9.5	12.5 10.3
Thickness swell -24 h soak	%	N/A	25	14	17	19
Linear expansion - oven dry to saturated	%	Para Perp	0.40 0.40	0.17 0.28	0.21 0.29	0.23 0.31
Lateral nail resistance	N	Para Perp	770 770	1118 1245	993 1052	805 874
Moisture content	%	N/A	Max. 8.0	2.0	2.0	2.0
Density	kg/m^3	N/A	No. Req.	660	608	593

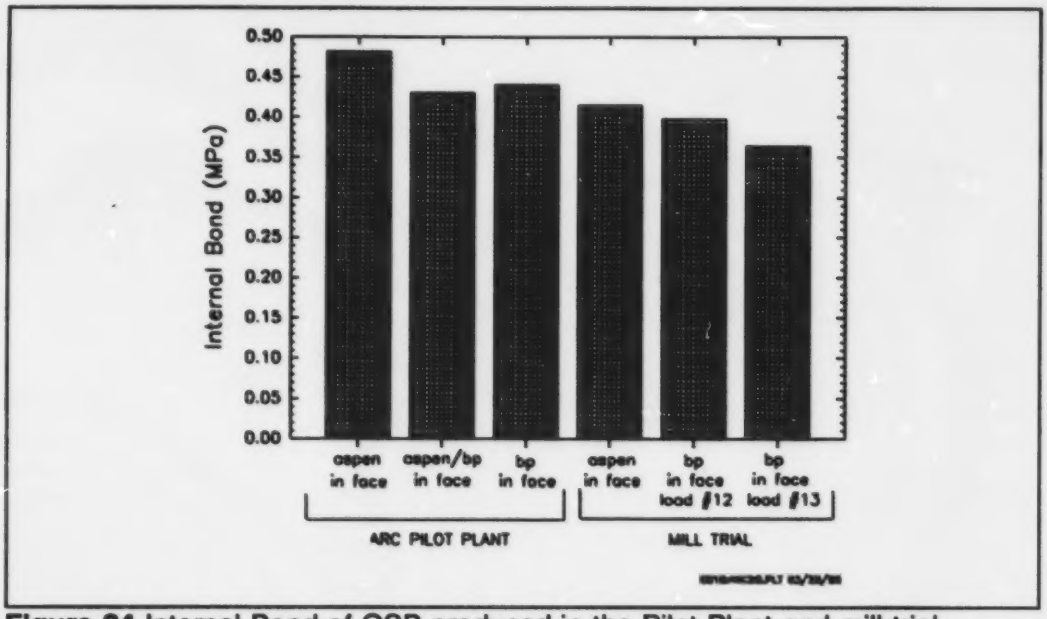

Figure 34 Internal Bond of OSB produced in the Pilot Plant and mill trial.

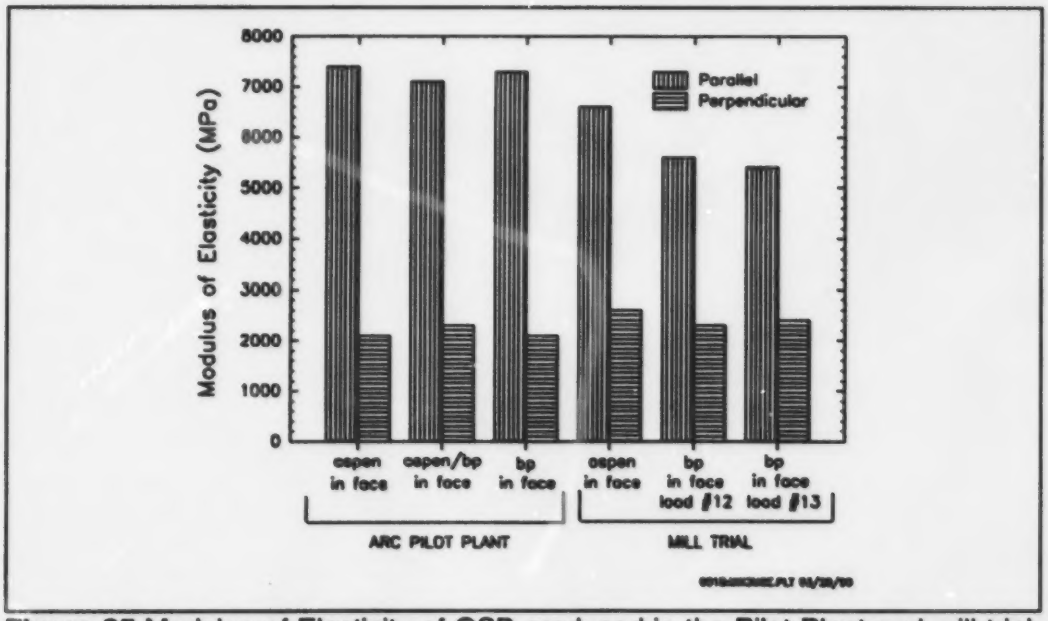

Figure 35 Modulus of Elasticity of OSB produced in the Pilot Plant and mill trial.

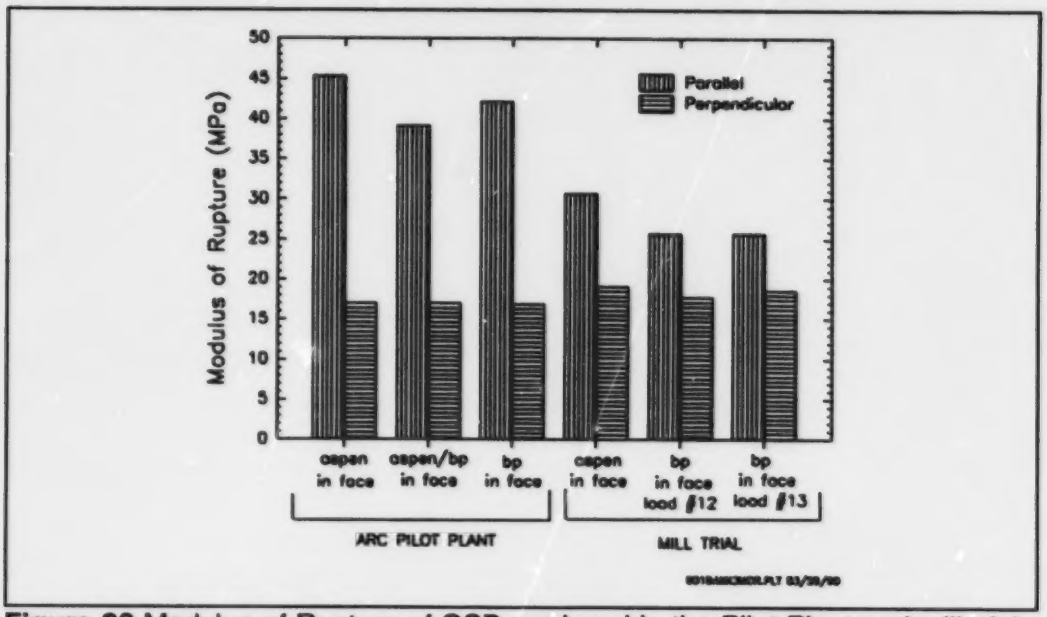

Figure 36 Modulus of Rupture of OSB produced in the Pilot Plant and mill trial.

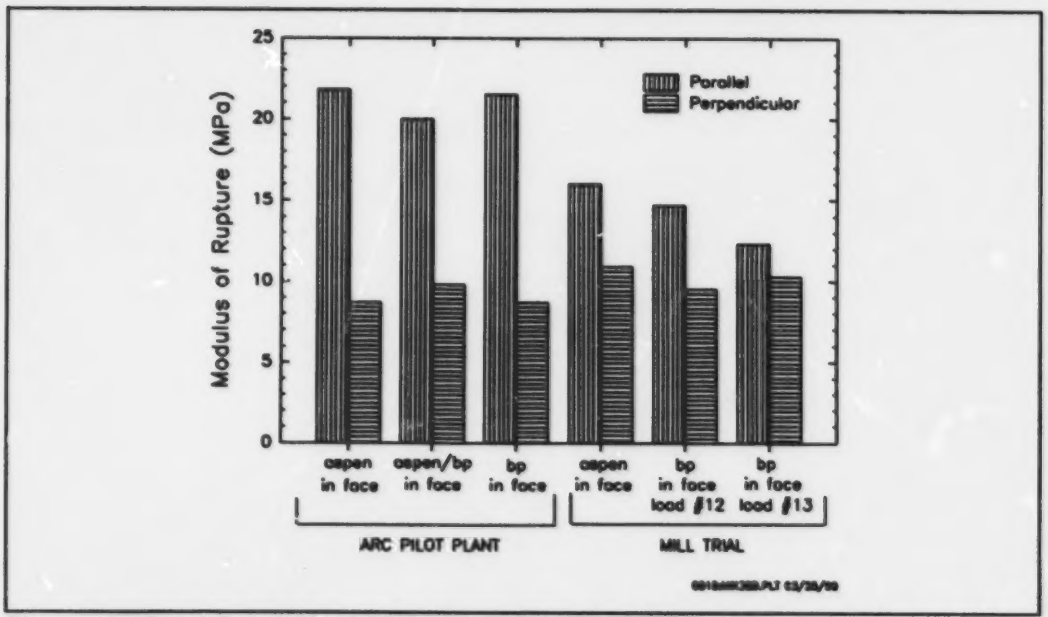

Figure 37 Bond Durability (MOR after 2 hr boil) of OSB produced in the Pilot Plant and mill trial.

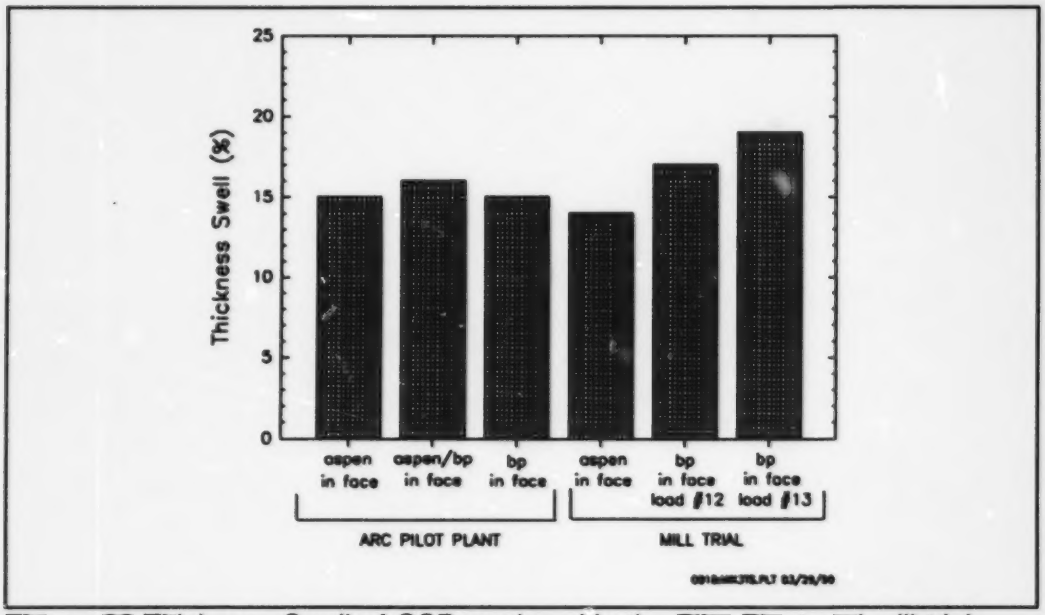

Figure 38 Thickness Swell of OSB produced in the Pilot Plant and mill trial.

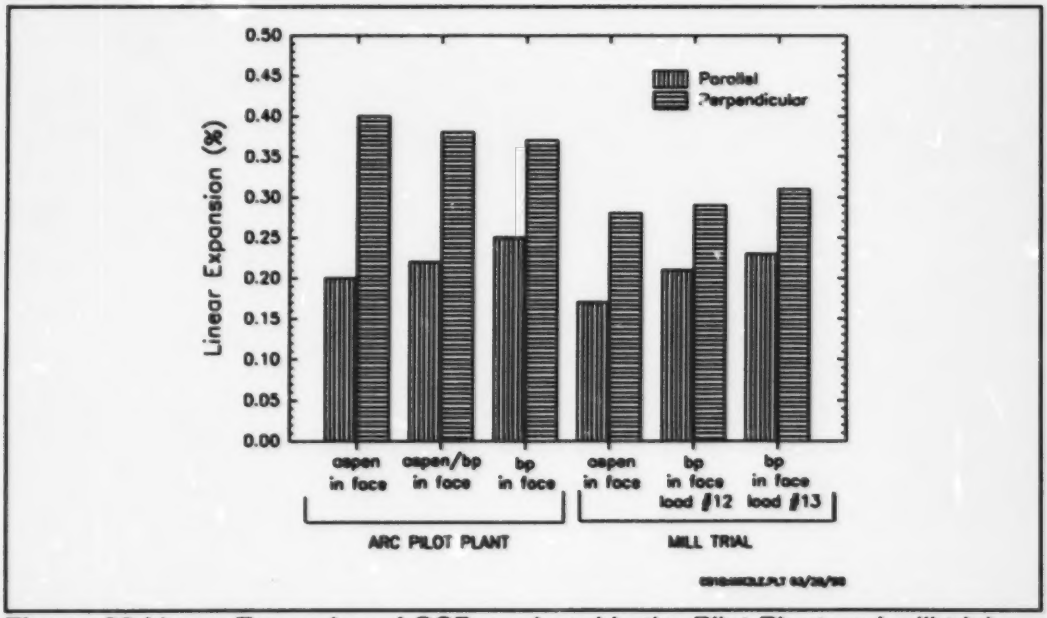

Figure 39 Linear Expansion of OSB produced in the Pilot Plant and mill trial.

5.5 Conclusions

From the results of the pilot plant trial with black poplar it can be concluded that:

1. Only a small reduction (less than 10%) in panel properties result from the use of black poplar in face of OSB.

2. Panels of similar specifications to commercial OSB can be made with black poplar to exceed CAN3-0437 0-2 requirements.

The mill trial with black poplar showed that:

1. Drying of black poplar is more difficult than aspen, but the difficulties can be overcome with proper setting adjustments.

2. The lower bulk density of the black poplar furnish causes problems in forming black poplar.

3. Even with their low density (600 kg/m^3) panels with black poplar in the face exceeded all CAN3-0437.0 0-2 requirements, except for MOR in the parallel direction.

6. CONCLUSIONS AND RECOMMENDATIONS FROM THE 1989/90 MIXED SPECIES PROJECT

Major conclusions from this project are:

I Strand yield and quality can be increased using either aspen or black poplar at lower moisture content during flaking. The significance of this to black poplar is that by conditioning the black poplar to a moisture content similar to aspen, similar strand quality can be achieved.

II Strand drying temperatures, in the range tried for this project, did not greatly alter panel properties. However, internal bond was slightly improved and thickness swell was slightly increased with higher drying temperature.

III Experience needs to be gained in handling black poplar in the mill. Differences in the moisture content and bulk density of the black poplar as compared to aspen require significant changes in operating parameters

As a result of this project it is recommended that another mill trial, but of a longer duration, be performed. Although the results of this year's mill trial were

better than the first, there was still not enough time to make all the necessary adjustments to produce acceptable boards using black poplar furnish. Processing changes due to black poplar have proved difficult to overcome in plant trials. A workshop involving current users of black poplar would be beneficial to gather information on the percent of black poplar used in industry and possible combinations of black poplar with other species.

7. REFERENCES

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2. Alberta Research Council, FPLE-176 Mixed Species: Black Poplar OSB Mill Trial, 1987.

3. Alberta Research Council, FPLE-164: Mixed Species, 1988.

4. Canadian Standards Association, CAN309437.0-M85 Waferboard and Strandboard, Toronto, Ontario, 1985.

5. Canadian Standards Association, CAN3-0437.1-M85 Test Methods for Waferboard and Strandboard, Toronto, Ontario, 1985.

6. Micko, M.M., Alberta Aspen vs. Black Poplar. Phase I - Wood Quality Differences, Department of Agricultural Engineering, University of Alberta, 1987 (through Alberta Research Council).

7. Micko, M.M., FPLC-24: Mixed Species: Wood/Fibre Characteristics Part One: Black Poplar Juvenile/Mature Wood, Department of Agricultural Engineering, University of Alberta, 1989 (through Alberta Research Council).

8. Morrison-Knudsen Forest Products Co. Inc., Ring Flaked Maxi-chips: The Manufacture, Testing and Evaluation of Composite Board Made from Alberta Woods, Report to: Jager Industries Inc., Calgary, 1987 (through Government of Alberta via FIDD and ARC).

9. Polyboard Manufacturing Corporation, FPLE-126: Pine Oriented Strandboard Manufacture and Testing, 1987, Prepared by Alberta Research Council.

10. Alberta Research Council, FPLE-225 Mixed Species (III), 1989.

11. Forintek Canada Corporation, Status of Balsam (Black) Poplar Utilization in Waferboard/OSB Production - A Summary Report, 1988.

Appendix A

Schedule "A" of Mixed Species Contract

ARC - Mixed Species

SCHEDULE "A"

The work in this project shall include the following tasks:

I. Effect of temperature and moisture content on strand yield and quality using aspen and black poplar in the laboratory. There will be four temperature/moisture content levels involved. From these one of the levels shall correspond to winter harvesting conditions (green frozen). The second level shall correspond to summer harvesting conditions (green unfrozen). The two other levels will be chosen between the first two in such a way as to facilitate the accurate determination of the effect of temperature/moisture content on strand yield and quality over the entire range of the four levels. Yield in this experiment consists of the determination of useable strand for the manufacture of OSB. Based on industry standards it is expressed as a ratio of output to input on weight basis. Quality in this experiment consists of the determination of strand geometry, edge conditions, smoothness, fuzziness, etc., based on industrial standards used for the manufacture of OSB.

II. Effect of drying temperature of dry strand yield and major board properties at four temperature levels. These levels will be chosen with practical consideration to end up with useable strands in the shortest possible drying time. The final moisture content of the dry strands will be chosen to correspond to commercial phenol formaldehyde and/or MDI resin(s) presently used by the Alberta OSB industry. The yield in this experiment has the same definition as in Item I. In this case it is the ratio of dry strand output (screened) from dryer to green strand input (screened) from dryer to green strand input (screened).

Testing will include stiffness rating and CAN/CSA 0437.0-M85 [Group I and LE(OD-SAT)] properties.

The panel for the tests shall be made as follows, example:*

Nominal thickness: 7/16"
Lay up - 30% top face aspen and phenol formaldehyde resin
- 40% core with 30% black poplar, 70% aspen and MDI resin
- 30% bottom face aspen and phenol formaldehyde resin
Panel size: 4'x8' (lab)
Panel number: 5

* This is an example only. Actual board specifications will be developed in cooperation with mill personal.

.../2

Schedule "A" (cont'd)

III. Mill trial based on the previous results and all other available knowledge. The plant process conditions from the green end to the finishing end shall be established in close communication with the plant manager and the technical director well in advance of the trial date. The following outline example will facilitate this process:

1.0 In cooperation with a mill establish the operation variables for the following:

Species	black poplar white aspen (combination of the two above) size and quality of logs.
Waferizer	RPM feed speed knife - make - thickness - wedge angle - carrier angle - separation - projection - sharpness counter knife - thickness - wedge angle - projection reactor knife spout to disc clearance
Dryers	settings - temperature - moisture content
Blending and Resination	- binder system application settings
Forming	- type of construction - thickness
Pressing	- pressing cycle (temperature, pressure & time)

.../3

Schedule "A" (cont'd)

Finishing	- panel size - panel sorting

2.0 In co-operation with a mill, establish areas to be observed, sampled/tested during the plant trial, example:

Log in feed	- origin - species - moisture content - density - quality
Debarking	- type of equipment - bark content - fiber losses
Waferizers	- type of equipment - strand geometry - strand classification - operation of the waferizer - moisture content
Forming	- type of equipment - quality of lay-up - moisture content - forming layers and mat-thickness
Pressing	- type of equipment - press cycle - press closure - press opening
Finishing	- type of equipment - quality control-mill - quality control-ARC
Production Evaluation	- APA (mill) - CSA 0437.0 (ARC)* - CSA 0325.0 (mill)

* Screening tests shall be completed to determine the effect on current mill's acceptance of the product.

.../4

Schedule "A" (cont'd)

The mill trial last year indicated that the strand generation improved from black poplar logs that have reduced moisture content. Accordingly, strands in this mill trial shall be cut from black poplar logs that have dried for some time.

The trial shall be based on the panel lay up specified earlier in Item II of Schedule "A".

IV. Prepare progress and final reports in accordance with Schedule "C".

V. The project will be audited in accordance with Schedule "D."

VI. If changes are required to the contract they shall be made in accordance with Schedule "E".

Appendix B

Measurements of Strand Geometry for Part I

Table B-1. Summary of flake geometry analysis for aspen waferized "green" and at 5°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 5.2% fines removed

Date: July, 1989
Material: Aspen, Green, 5C

Data File: GS9A-2

Disk ID: PLGD - 9

No. of Samples: 109

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.61	51.8	7.5	10.59	94.9
Std. Deviation	0.29	22.5	6.6	7.36	51.5
95 % C.I. +/-	0.06	4.2	1.2	1.38	9.7
Upper Limit	0.66	56.1	8.8	11.97	104.5
Lower limit	0.55	47.6	6.3	9.21	85.2
Low	0.15	9.1	0.8	1.83	11.5
Median	0.58	55.7	5.0	9.79	90.8
High	2.23	86.4	28.0	49.70	291.0

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.06
	0.10	0.00	10.0	0.03	3.0	0.41
	0.20	0.03	20.0	0.13	6.0	0.21
	0.30	0.04	30.0	0.16	9.0	0.08
	0.40	0.10	40.0	0.11	12.0	0.06
	0.50	0.23	50.0	0.06	15.0	0.03
	0.60	0.40	60.0	0.10	18.0	0.06
	0.70	0.13	70.0	0.24	21.0	0.05
	0.80	0.02	80.0	0.17	24.0	0.03
	0.90	0.01	90.0	0.01	27.0	0.02
	1.00	0.00	100.0	0.00	30.0	0.00
	1.10	0.00	110.0	0.00	33.0	0.00
	1.20	0.00	120.0	0.00	36.0	0.00
	1.30	0.00	130.0	0.00	39.0	0.00
	> 1.35	0.05	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

Table B-2. Summary of flake geometry analysis for aspen waferized "green" and at 20°C

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 2.2% fines removed

Date: July, 1989
Material: Aspen, Green, 20C

Data File: GS9A-3

Disk ID: PLGD - 9

No. of Samples: 102

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.59	60.1	11.5	8.73	106.0
Std. Deviation	0.19	21.2	8.0	8.01	37.0
95 % C.I. +/-	0.04	4.1	1.6	1.56	7.2
Upper Limit	0.63	64.2	13.1	10.28	113.2
Lower limit	0.55	56.0	10.0	7.17	98.8
Low	0.14	14.0	0.9	1.78	20.2
Median	0.61	68.9	10.4	5.74	109.2
High	1.72	90.2	39.7	50.74	189.7

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.04
	0.10	0.01	10.0	0.01	3.0	0.22
	0.20	0.03	20.0	0.10	6.0	0.11
	0.30	0.05	30.0	0.08	9.0	0.15
	0.40	0.10	40.0	0.09	12.0	0.15
	0.50	0.14	50.0	0.04	15.0	0.07
	0.60	0.34	60.0	0.08	18.0	0.11
	0.70	0.23	70.0	0.31	21.0	0.08
	0.80	0.08	80.0	0.27	24.0	0.04
	0.90	0.00	90.0	0.02	27.0	0.02
	1.00	0.02	100.0	0.00	30.0	0.01
	1.10	0.00	110.0	0.00	33.0	0.01
	1.20	0.00	120.0	0.00	36.0	0.00
	1.30	0.00	130.0	0.00	39.0	0.01
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

Table B-3. Summary of flake geometry analysis for aspen waferized "green" and at 50°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 1.7% fines removed

Date: July, 1989
Material: Aspen, Green, 50C

Data File: GS9A-4

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.61	58.8	14.0	9.65	99.8
Std. Deviation	0.20	21.4	15.3	10.23	36.5
95 % C.I. +/-	0.04	4.2	3.0	2.00	7.2
Upper Limit	0.65	63.0	17.1	11.65	107.0
Lower limit	0.57	54.6	11.0	7.64	92.7
Low	0.15	12.2	1.4	0.90	20.0
Median	0.60	69.4	8.6	6.28	101.6
High	1.49	87.1	84.7	56.62	217.6

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.03
	0.10	0.01	10.0	0.02	3.0	0.31
	0.20	0.01	20.0	0.09	6.0	0.13
	0.30	0.06	30.0	0.08	9.0	0.08
	0.40	0.10	40.0	0.12	12.0	0.11
	0.50	0.20	50.0	0.07	15.0	0.07
	0.60	0.19	60.0	0.06	18.0	0.03
	0.70	0.24	70.0	0.23	21.0	0.03
	0.80	0.09	80.0	0.32	24.0	0.04
	0.90	0.07	90.0	0.01	27.0	0.03
	1.00	0.01	100.0	0.00	30.0	0.03
	1.10	0.00	110.0	0.00	33.0	0.01
	1.20	0.01	120.0	0.00	36.0	0.01
	1.30	0.00	130.0	0.00	39.0	0.02
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.07
Total:		1.00		1.00		1.00

Table B-4. Summary of flake geometry analysis for aspen waferized "semi-dried" and at 5°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 2.5% fines removed

Date: July, 1989
Material: Aspen, Dry, 5C

Data File: GS9A-6

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.59	53.1	8.9	11.16	94.3
Std. Deviation	0.19	22.0	7.2	11.12	36.6
95 % C.I. +/-	0.04	4.3	1.4	2.18	7.2
Upper Limit	0.62	57.4	10.3	13.33	101.5
Lower limit	0.55	48.8	7.5	8.98	87.1
Low	0.14	10.7	1.1	1.25	21.9
Median	0.59	57.2	6.3	6.81	96.3
High	1.33	86.6	32.4	68.17	228.4

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.11
	0.10	0.01	10.0	0.02	3.0	0.26
	0.20	0.04	20.0	0.11	6.0	0.18
	0.30	0.06	30.0	0.16	9.0	0.09
	0.40	0.04	40.0	0.08	12.0	0.09
	0.50	0.25	50.0	0.13	15.0	0.10
	0.60	0.27	60.0	0.10	18.0	0.10
	0.70	0.18	70.0	0.21	21.0	0.02
	0.80	0.10	80.0	0.16	24.0	0.01
	0.90	0.02	90.0	0.03	27.0	0.02
	1.00	0.01	100.0	0.00	30.0	0.01
	1.10	0.00	110.0	0.00	33.0	0.01
	1.20	0.01	120.0	0.00	36.0	0.00
	1.30	0.01	130.0	0.00	39.0	0.00
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

Table B-5. Summary of flake geometry analysis for aspen waferized "semi-dried" and at 20°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 1.2% fines removed

Date: July, 1989
Material: Aspen, Dry, 20C

Data File: GS9A-7

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.57	62.4	9.7	12.20	116.7
Std. Deviation	0.14	19.0	7.5	11.79	43.3
95 % C.I. +/-	0.03	3.7	1.5	2.31	8.5
Upper Limit	0.60	66.1	11.2	14.51	125.2
Lower limit	0.54	58.7	8.2	9.89	108.2
Low	0.12	20.0	1.0	1.15	37.2
Median	0.58	70.7	7.8	7.93	119.0
High	0.92	85.0	31.8	66.69	258.0

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.01
	0.10	0.02	10.0	0.00	3.0	0.35
	0.20	0.03	20.0	0.04	6.0	0.12
	0.30	0.01	30.0	0.13	9.0	0.12
	0.40	0.09	40.0	0.06	12.0	0.10
	0.50	0.18	50.0	0.06	15.0	0.13
	0.60	0.42	60.0	0.04	18.0	0.08
	0.70	0.18	70.0	0.38	21.0	0.02
	0.80	0.05	80.0	0.29	24.0	0.02
	0.90	0.02	90.0	0.00	27.0	0.02
	1.00	0.00	100.0	0.00	30.0	0.01
	1.10	0.00	110.0	0.00	33.0	0.02
	1.20	0.00	120.0	0.00	36.0	0.00
	1.30	0.00	130.0	0.00	39.0	0.00
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

Table B-6. Summary of flake geometry analysis for aspen waferized "semi-dried" and at 50°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 1.5% fines removed

Date: July, 1989
Material: Aspen, Dry, 50C

Data File: GS9A-8

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.57	57.0	13.5	8.15	107.6
Std. Deviation	0.16	22.6	15.0	6.86	55.7
95 % C.I. +/-	0.03	4.4	2.9	1.35	10.9
Upper Limit	0.60	61.4	16.4	9.49	118.5
Lower limit	0.54	52.5	10.5	6.80	96.7
Low	0.12	7.7	1.2	0.66	15.3
Median	0.59	65.1	8.9	5.63	105.6
High	1.38	117.4	105.3	39.42	400.7

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.01
	0.10	0.02	10.0	0.03	3.0	0.28
	0.20	0.02	20.0	0.06	6.0	0.14
	0.30	0.06	30.0	0.15	9.0	0.12
	0.40	0.06	40.0	0.09	12.0	0.09
	0.50	0.24	50.0	0.09	15.0	0.09
	0.60	0.38	60.0	0.08	18.0	0.06
	0.70	0.14	70.0	0.21	21.0	0.05
	0.80	0.07	80.0	0.26	24.0	0.05
	0.90	0.00	90.0	0.02	27.0	0.01
	1.00	0.00	100.0	0.00	30.0	0.02
	1.10	0.00	110.0	0.00	33.0	0.02
	1.20	0.00	120.0	0.01	36.0	0.02
	1.30	0.00	130.0	0.00	39.0	0.00
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.04
Total:		1.00		1.00		1.00

Table B-7 Summary of flake geometry analysis for black poplar waferized "green" and at 5°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 4.7% of Fines Removed

Date: June 30, 1989
Material: Black Poplar, Green, 5C

Data File: GS9B-2

Disk ID: PLGD - 9

No. of Samples: 107

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.55	40.8	7.5	7.01	77.1
Std. Deviation	0.27	21.9	4.6	5.70	34.5
95 % C.I. +/-	0.05	4.2	0.9	1.08	6.5
Upper Limit	0.60	44.9	8.4	8.09	83.6
Lower limit	0.50	36.6	6.7	5.93	70.6
Low	0.15	8.0	1.2	1.19	19.2
Median	0.55	38.7	6.7	5.24	73.7
High	2.48	85.4	22.8	32.14	180.1

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.03
	0.10	0.01	10.0	0.09	3.0	0.26
	0.20	0.07	20.0	0.25	6.0	0.31
	0.30	0.11	30.0	0.13	9.0	0.17
	0.40	0.12	40.0	0.11	12.0	0.12
	0.50	0.22	50.0	0.14	15.0	0.06
	0.60	0.28	60.0	0.05	18.0	0.04
	0.70	0.09	70.0	0.14	21.0	0.01
	0.80	0.05	80.0	0.07	24.0	0.01
	0.90	0.02	90.0	0.01	27.0	0.00
	1.00	0.01	100.0	0.00	30.0	0.00
	1.10	0.00	110.0	0.00	33.0	0.00
	1.20	0.00	120.0	0.00	36.0	0.00
	1.30	0.00	130.0	0.00	39.0	0.00
	> 1.35	0.02	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

Table B-8. Summary of flake geometry analysis for black poplar waferized "green" and at 20°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 3.8% fines removed

Date: July, 1989
Material: Black Poplar, Green, 20C

Data File: GS9B-3

Disk ID: PLGD - 9

No. of Samples: 122

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.62	48.4	9.4	7.44	86.7
Std. Deviation	0.25	22.3	7.0	5.63	47.4
95 % C.I. +/-	0.04	4.0	1.2	1.00	8.4
Upper Limit	0.66	52.3	10.6	8.44	95.1
Lower limit	0.57	44.4	8.2	6.44	78.3
Low	0.16	12.5	1.3	1.32	19.3
Median	0.62	46.3	7.7	6.11	78.5
High	2.31	116.3	34.6	42.83	249.8

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.02
	0.10	0.00	10.0	0.02	3.0	0.27
	0.20	0.06	20.0	0.18	6.0	0.21
	0.30	0.05	30.0	0.16	9.0	0.16
	0.40	0.07	40.0	0.12	12.0	0.13
	0.50	0.20	50.0	0.13	15.0	0.06
	0.60	0.23	60.0	0.06	18.0	0.06
	0.70	0.25	70.0	0.17	21.0	0.02
	0.80	0.07	80.0	0.13	24.0	0.03
	0.90	0.02	90.0	0.01	27.0	0.02
	1.00	0.02	100.0	0.00	30.0	0.02
	1.10	0.00	110.0	0.00	33.0	0.00
	1.20	0.00	120.0	0.01	36.0	0.01
	1.30	0.02	130.0	0.00	39.0	0.00
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

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Table B-9. Summary of flake geometry analysis for black poplar waferized "green" and at 5°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 6.3% fines removed

Date: July, 1989
Material: Black Poplar, Green, 50C

Data File: GS9B-4

Disk ID: PLGD - 9

No. of Samples: 111

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.63	41.6	9.0	7.04	71.1
Std. Deviation	0.29	23.3	7.5	7.03	38.8
95 % C.I. +/-	0.05	4.3	1.4	1.31	7.2
Upper Limit	0.68	45.9	10.4	8.35	78.3
Lower limit	0.57	37.3	7.6	5.73	63.8
Low	0.20	8.8	1.3	1.28	12.9
Median	0.61	37.2	6.4	4.47	66.8
High	2.41	98.6	35.5	45.96	174.7

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.03
	0.10	0.00	10.0	0.12	3.0	0.27
	0.20	0.04	20.0	0.17	6.0	0.29
	0.30	0.08	30.0	0.19	9.0	0.12
	0.40	0.08	40.0	0.13	12.0	0.10
	0.50	0.19	50.0	0.10	15.0	0.07
	0.60	0.26	60.0	0.06	18.0	0.02
	0.70	0.16	70.0	0.12	21.0	0.04
	0.80	0.08	80.0	0.10	24.0	0.00
	0.90	0.05	90.0	0.01	27.0	0.03
	1.00	0.01	100.0	0.01	30.0	0.02
	1.10	0.00	110.0	0.00	33.0	0.02
	1.20	0.01	120.0	0.00	36.0	0.01
	1.30	0.01	130.0	0.00	39.0	0.00
	> 1.35	0.03	> 135.0	0.00	> 40.5	0.00
Total:		1.00		1.00		1.00

Table B-10. Summary of flake geometry analysis for black poplar waferized "semi-dried" and at 5°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 9.4% fines removed

Date: July, 1989
Material: Black Poplar, Dry, 5C

Data File: GS9B-6

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.67	54.8	10.7	8.63	84.9
Std. Deviation	0.18	21.4	10.3	8.44	36.9
95 % C.I. +/-	0.03	4.2	2.0	1.65	7.2
Upper Limit	0.70	59.0	12.7	10.29	92.2
Lower limit	0.63	50.6	8.7	6.98	77.7
Low	0.20	11.6	0.8	1.01	24.5
Median	0.67	59.8	7.3	5.78	84.6
High	1.34	86.0	73.0	65.07	256.9

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.03
	0.10	0.00	10.0	0.02	3.0	0.25
	0.20	0.02	20.0	0.11	6.0	0.23
	0.30	0.02	30.0	0.11	9.0	0.07
	0.40	0.05	40.0	0.14	12.0	0.14
	0.50	0.09	50.0	0.08	15.0	0.12
	0.60	0.25	60.0	0.09	18.0	0.06
	0.70	0.28	70.0	0.21	21.0	0.01
	0.80	0.18	80.0	0.23	24.0	0.04
	0.90	0.05	90.0	0.01	27.0	0.00
	1.00	0.05	100.0	0.00	30.0	0.00
	1.10	0.00	110.0	0.00	33.0	0.00
	1.20	0.00	120.0	0.00	36.0	0.02
	1.30	0.01	130.0	0.00	39.0	0.01
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.02
Total:		1.00		1.00		1.00

Table B-11. Summary of flake geometry analysis for black poplar waferized "semi-dried" and at 2°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 2.2% fines removed

Date: July, 1989
Material: Black Poplar, Dry, 20C

Data File: GS9B-7

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.59	51.8	10.8	6.67	90.4
Std. Deviation	0.15	22.1	7.6	4.68	39.4
95 % C.I. +/-	0.03	4.3	1.5	0.92	7.7
Upper Limit	0.62	56.2	12.3	7.58	98.1
Lower limit	0.56	47.5	9.3	5.75	82.6
Low	0.15	9.2	2.3	1.45	20.6
Median	0.61	55.5	9.0	5.16	93.1
High	1.05	92.9	47.3	20.60	218.6

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.00
	0.10	0.01	10.0	0.03	3.0	0.24
	0.20	0.02	20.0	0.11	6.0	0.19
	0.30	0.04	30.0	0.16	9.0	0.17
	0.40	0.09	40.0	0.13	12.0	0.10
	0.50	0.15	50.0	0.07	15.0	0.12
	0.60	0.36	60.0	0.08	18.0	0.06
	0.70	0.24	70.0	0.29	21.0	0.04
	0.80	0.05	80.0	0.10	24.0	0.05
	0.90	0.02	90.0	0.03	27.0	0.01
	1.00	0.01	100.0	0.00	30.0	0.00
	1.10	0.01	110.0	0.00	33.0	0.01
	1.20	0.00	120.0	0.00	36.0	0.00
	1.30	0.00	130.0	0.00	39.0	0.00
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.01
Total:		1.00		1.00		1.00

Table B-12. Summary of flake geometry analysis for black poplar waferized "semi-dried" and at 50°C.

TABLE ID: PLGS - 9
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 1.3% fines removed

Date: July, 1989
Material: Black Poplar, Dry, 50C

Data File: GS9B-8

Disk ID: PLGD - 9

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.62	57.1	17.0	5.67	103.9
Std. Deviation	0.21	22.1	14.3	4.74	56.4
95 % C.I. +/-	0.04	4.3	2.8	0.93	11.1
Upper Limit	0.66	61.5	19.8	6.59	114.9
Lower limit	0.58	52.8	14.1	4.74	92.8
Low	0.11	12.0	1.8	0.81	17.7
Median	0.62	63.3	13.8	4.33	100.0
High	1.80	98.0	91.8	23.09	423.0

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.00
	0.10	0.02	10.0	0.02	3.0	0.14
	0.20	0.04	20.0	0.08	6.0	0.20
	0.30	0.04	30.0	0.14	9.0	0.09
	0.40	0.04	40.0	0.09	12.0	0.07
	0.50	0.16	50.0	0.09	15.0	0.12
	0.60	0.26	60.0	0.09	18.0	0.07
	0.70	0.27	70.0	0.23	21.0	0.04
	0.80	0.11	80.0	0.20	24.0	0.04
	0.90	0.03	90.0	0.05	27.0	0.03
	1.00	0.00	100.0	0.01	30.0	0.03
	1.10	0.01	110.0	0.00	33.0	0.05
	1.20	0.01	120.0	0.00	36.0	0.05
	1.30	0.00	130.0	0.00	39.0	0.02
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.05
Total:		1.00		1.00		1.00

Appendix C

Measurements of Strand Geometry for Part II

Table C-1. Summary of flake geometry analysis for aspen waferized on the lab waferizer.

TABLE ID: PLGS - 12
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 2.0% fines removed (<3/8")

Date: October 6, 1989
Material: ARC Aspen 08/15/89

Data File: PLGS12

Disk ID: PLGD - 12

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.63	67.7	13.3	8.55	111.4
Std. Deviation	0.12	12.4	9.6	7.16	30.1
95 % C.I. +/-	0.02	2.4	1.9	1.40	5.9
Upper Limit	0.65	70.2	15.2	9.95	117.3
Lower limit	0.61	65.3	11.4	7.14	105.5
Low	0.31	26.1	1.9	1.22	33.0
Median	0.63	70.9	10.8	6.54	110.8
High	1.19	85.6	61.0	38.39	215.7

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.00
	0.10	0.00	10.0	0.00	3.0	0.13
	0.20	0.00	20.0	0.00	6.0	0.23
	0.30	0.01	30.0	0.03	9.0	0.11
	0.40	0.03	40.0	0.05	12.0	0.08
	0.50	0.15	50.0	0.05	15.0	0.15
	0.60	0.41	60.0	0.18	18.0	0.06
	0.70	0.32	70.0	0.41	21.0	0.09
	0.80	0.03	80.0	0.26	24.0	0.05
	0.90	0.03	90.0	0.02	27.0	0.03
	1.00	0.00	100.0	0.00	30.0	0.04
	1.10	0.01	110.0	0.00	33.0	0.00
	1.20	0.01	120.0	0.00	36.0	0.01
	1.30	0.00	130.0	0.00	39.0	0.01
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.01
Total:		1.00		1.00		1.00

Table C-2. Summary of flake geometry analysis for black poplar waferized on the lab waferizer.

TABLE ID: PLGS - 13
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mixed Species
Proj. No.: 406-023-00
Comments: 4.9% fines removed (<3/8")

Date: October 6, 1989
Material: ARC B.P. 08/16/89

Data File: PLGS13

Disk ID: PLGD - 13

No. of Samples: 100

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.63	59.9	11.5	8.07	101.1
Std. Deviation	0.13	16.6	8.9	6.31	51.1
95 % C.I. +/-	0.02	3.3	1.8	1.24	10.0
Upper Limit	0.66	63.1	13.3	9.30	111.1
Lower limit	0.61	56.6	9.8	6.83	91.1
Low	0.16	27.2	1.6	1.35	30.7
Median	0.65	65.7	9.4	5.93	95.5
High	1.10	89.5	47.5	39.56	465.9

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.00
	0.10	0.00	10.0	0.00	3.0	0.17
	0.20	0.01	20.0	0.00	6.0	0.20
	0.30	0.03	30.0	0.10	9.0	0.20
	0.40	0.04	40.0	0.14	12.0	0.18
	0.50	0.06	50.0	0.14	15.0	0.08
	0.60	0.39	60.0	0.12	18.0	0.03
	0.70	0.41	70.0	0.30	21.0	0.03
	0.80	0.02	80.0	0.17	24.0	0.05
	0.90	0.02	90.0	0.03	27.0	0.01
	1.00	0.01	100.0	0.00	30.0	0.01
	1.10	0.01	110.0	0.00	33.0	0.00
	1.20	0.00	120.0	0.00	36.0	0.01
	1.30	0.00	130.0	0.00	39.0	0.00
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.03
Total:		1.00		1.00		1.00

Appendix D

Individual Panel Test Results from Part II

Table D-1. Summary of grade properties for strandboard made of aspen furnish dried at 50°C.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C.
Test Date: November 3, 1989
Proj.Ref.: 40601300

Test Material: Waferboard, Random
Nom. Thickness: 11.0 mm
Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number A1-1	A1-2	A1-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	25.2	31.8	36.9	31.3
		17.2	Perp	33.0	34.3	34.6	34.0
Modulus of elasticity	MPa	3100	Para	3900	4400	4600	4300
		3100	Perp	4100	4700	4200	4300
Internal bond	MPa	0.345		0.776	0.803	0.838	0.806
Bond durability - MOR after 2 h boil	MPa	8.6	Para	16.6	21.6	19.4	19.2
		8.6	Perp	18.3	20.7	24.5	21.2
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		17	19	17	18
Moisture Content -	%	Max. 8.0		3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		629	647	659	645
Linear expansion - oven dry to saturated	%	0.40	Para	0.30	0.26	0.34	0.30
		0.40	Perp	0.24	0.25	0.30	0.26

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-2. Summary of grade properties for strandboard made of aspen furnish fried at 100°C.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C.
Test Date: November 3, 1989
Proj.Ref.: 40601300

Test Material: Waferboard, Random
Nom. Thickness: 11.0 mm
Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number A2-1	A2-2	A2-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	28.6	28.1	29.6	28.8
		17.2	Perp	41.3	35.6	33.9	37.0
Modulus of elasticity	MPa	3100	Para	4300	3900	4200	4100
		3100	Perp	5100	5500	4700	5100
Internal bond	MPa	0.345		0.779	0.767	0.702	0.749
Bond durability - MOR after 2 h boil	MPa	8.6	Para	14.8	18.0	13.7	15.5
		8.6	Perp	19.5	23.2	16.0	19.6
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		18	16	18	17
Moisture Content -	%	Max. 8.0		3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		656	646	649	650
Linear expansion - oven dry to saturated	%	0.40	Para	0.29	0.30	0.30	0.30
		0.40	Perp	0.25	0.27	0.24	0.25

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-3. Summary of grade properties for strandboard made of aspen furnish fried at 125°C.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C. Test Material: Waferboard, Random
Test Date: November 3, 1989 Nom. Thickness: 11.0 mm
Proj.Ref.: 40601300 Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number A3-1	A3-2	A3-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	26.4	29.8	34.1	30.1
		17.2	Perp	38.0	30.2	38.5	35.6
Modulus of elasticity	MPa	3100	Para	3700	4200	4500	4100
		3100	Perp	4800	4600	5400	4900
Internal bond	MPa	0.345		0.786	0.769	0.690	0.748
Bond durability - MOR after 2 h boil	MPa	8.6	Para	16.1	17.1	18.5	17.2
		8.6	Perp	19.5	16.7	21.2	19.1
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		17	17	15	16
Moisture Content -	%	Max. 8.0		3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		641	641	705	662
Linear expansion - oven dry to saturated	%	0.40	Para	0.32	0.27	0.25	0.28
		0.40	Perp	0.26	0.27	0.25	0.26

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-4. Summary of grade properties for strandboard made of aspen furnish dried at 150°C.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C. Test Material: Waferboard, Random
Test Date: November 3, 1989 Nom. Thickness: 11.0 mm
Proj.Ref.: 40601300 Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number A4-1	A4-2	A4-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	32.3	30.5	34.0	32.2
		17.2	Perp	36.6	32.5	34.5	34.5
Modulus of elasticity	MPa	3100	Para	4700	4500	4300	4500
		3100	Perp	5500	4900	4500	5000
Internal bond	MPa	0.345		0.660	0.655	0.677	0.664
Bond durability - MOR after 2 h boil	MPa	8.6	Para	17.6	17.8	22.1	19.1
		8.6	Perp	20.6	18.2	18.7	19.2
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		16	14	14	14
Moisture Content -	%	Max. 8.0		3.0	3.0	2.0	3.0
Density -	kg/cu.m	No Requirement		649	699	674	674
Linear expansion - oven dry to saturated	%	0.40	Para	0.30	0.33	0.25	0.29
		0.40	Perp	0.26	0.23	0.28	0.25

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-5. Summary of grade properties for strandboard made of black poplar furnish dried at 50°C.

GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C.
Test Date: November 8, 1989
Proj.Ref.: 40601300

Test Material: Waferboard, Random
Nom. Thickness: 11.0 mm
Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number B1-1	B1-2	B1-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	24.8	32.9	30.6	29.5
		17.2	Perp	37.2	30.7	29.4	32.4
Modulus of elasticity	MPa	3100	Para	3600	4700	4100	4100
		3100	Perp	4600	4600	4200	4500
Internal bond	MPa	0.345		0.671	0.650	0.715	0.679
Bond durability - MOR after 2 h boil	MPa	8.6	Para	14.5	13.3	15.5	14.5
		8.6	Perp	14.9	18.5	17.2	16.9
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		19	18	19	19
Moisture Content -	%	Max. 8.0		3.0	2.0	3.0	3.0
Density -	kg/cu.m	No Requirement		682	675	621	659
Linear expansion - oven dry to saturated	%	0.40	Para	0.23	0.29	0.24	0.25
		0.40	Perp	0.31	0.32	0.27	0.30

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-6. Summary of grade properties for strandboard made of black poplar dried at 100°C.

GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C.
Test Date: November 8, 1989
Proj.Ref.: 40601300

Test Material: Waferboard, Random
Nom. Thickness: 11.0 mm
Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number B2-1	B2-2	B2-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	26.1	29.1	26.1	27.1
		17.2	Perp	32.3	30.1	26.8	29.7
Modulus of elasticity	MPa	3100	Para	4100	4100	4000	4100
		3100	Perp	4700	4400	4100	4400
Internal bond	MPa	0.345		0.542	0.557	0.689	0.596
Bond durability - MOR after 2 h boil	MPa	8.6	Para	14.4	14.3	13.7	14.1
		8.6	Perp	17.4	18.1	16.3	17.3
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		20	19	19	19
Moisture Content -	%	Max. 8.0		3.0	2.0	2.0	3.0
Density -	kg/cu.m	No Requirement		634	638	632	635
Linear expansion - oven dry to saturated	%	0.40	Para	0.32	0.32	0.26	0.30
		0.40	Perp	0.26	0.27	0.27	0.27

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-7. Summary of grade properties for strandboard made of black poplar furnish dried at 125°C.

GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C.
Test Date: November 8, 1989
Proj.Ref.: 40601300

Test Material: Waferboard, Random
Nom. Thickness: 11.0 mm
Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number B3-1	B3-2	B3-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	20.9	30.4	25.6	25.6
		17.2	Perp	29.0	34.0	30.6	31.2
Modulus of elasticity	MPa	3100	Para	3100	4600	3900	3900
		3100	Perp	4600	4600	4200	4500
Internal bond	MPa	0.345		0.627	0.673	0.648	0.649
Bond durability - MOR after 2 h boil	MPa	8.6	Para	11.8	13.6	15.9	13.8
		8.6	Perp	14.5	20.8	18.6	18.0
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		20	19	18	19
Moisture Content -	%	Max. 8.0		2.0	2.0	3.0	3.0
Density -	kg/cu.m	No Requirement		597	660	610	622
Linear expansion - oven dry to saturated	%	0.40	Para	0.29	0.26	0.24	0.26
		0.40	Perp	0.29	0.23	0.24	0.25

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Table D-8. Summary of grade properties for strandboard made of black poplar furnish dried at 150°C.

GRADE PROPERTIES
(CAN3-0437.0-M85)

Client: A.R.C.
Test Date: November 8, 1989
Proj.Ref.: 40601300

Test Material: Waferboard, Random
Nom. Thickness: 11.0 mm
Conditioning: As per test Requirement

Group 1	Units	(CAN3-0437) R-1 Req.	Dir'n	Panel Number B4-1	B4-2	B4-3	3 Panel Average
Modulus of rupture	MPa	17.2	Para	29.0	28.5	25.1	27.5
		17.2	Perp	32.1	29.6	30.3	30.7
Modulus of elasticity	MPa	3100	Para	4400	4000	3900	4100
		3100	Perp	4600	4100	4200	4300
Internal bond	MPa	0.345		0.605	0.705	0.684	0.665
Bond durability - MOR after 2 h boil	MPa	8.6	Para	14.7	12.8	11.2	12.9
		8.6	Perp	14.3	14.2	14.3	14.3
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25		15	17	17	16
Moisture Content -	%	Max. 8.0		3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		650	597	593	613
Linear expansion - oven dry to saturated	%	0.40	Para	0.30	0.30	0.30	0.30
		0.40	Perp	0.32	0.30	0.30	0.31

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Appendix E

Measurements of Strand for Part III (mill trial)

Table E-1. Summary of flake geometry analysis for aspen furnish collected before the dryer and screener.

TABLE ID: PLGS - 25
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mill Trial — Date: March 7, 1990
Proj. No.: 406-023-00 — Material: Aspen, Flaker 3
Comments: 7.8% fines removed

Data File: plgs25 — Disk ID: PLGD - 23

No. of Samples: 200

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.58	62.5	9.6	10.50	123.6
Std. Deviation	0.21	19.5	8.8	6.91	67.5
95 % C.I. +/-	0.03	2.7	1.2	0.96	9.3
Upper Limit	0.61	65.2	10.8	11.45	132.9
Lower limit	0.55	59.7	8.4	9.54	114.2
Low	0.13	17.9	1.5	1.18	20.2
Median	0.55	74.1	6.7	9.28	113.5
High	1.56	86.8	55.1	40.81	619.1

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.01
	0.10	0.01	10.0	0.00	3.0	0.26
	0.20	0.03	20.0	0.02	6.0	0.31
	0.30	0.04	30.0	0.13	9.0	0.19
	0.40	0.22	40.0	0.13	12.0	0.04
	0.50	0.23	50.0	0.09	15.0	0.06
	0.60	0.21	60.0	0.08	18.0	0.03
	0.70	0.10	70.0	0.11	21.0	0.04
	0.80	0.08	80.0	0.46	24.0	0.01
	0.90	0.04	90.0	0.01	27.0	0.02
	1.00	0.03	100.0	0.00	30.0	0.03
	1.10	0.00	110.0	0.00	33.0	0.02
	1.20	0.02	120.0	0.00	36.0	0.00
	1.30	0.01	130.0	0.00	39.0	0.01
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.02
Total:		1.00		1.00		1.00

Table E-2. Summary of flake geometry analysis for black poplar furnish collected before the dryer and screener.

TABLE ID: PLGS - 26
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mill Trial
Proj. No.: 406-023-00
Comments: % fines removed
Reference to PLGS-26
Data File: plgs26

Date: March 9, 1990
Material: B.P., Flaker 3
Disk ID: PLGD - 23

No. of Samples: 200

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.52	59.2	9.1	10.66	129.6
Std. Deviation	0.21	21.3	9.2	8.18	70.4
95 % C.I. +/-	0.03	3.0	1.3	1.13	9.8
Upper Limit	0.55	62.1	10.3	11.79	139.4
Lower limit	0.50	56.2	7.8	9.53	119.9
Low	0.14	14.6	1.2	0.88	18.7
Median	0.50	64.7	6.2	7.88	118.0
High	1.20	88.8	90.9	42.56	376.1

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.01
	0.10	0.01	10.0	0.01	3.0	0.30
	0.20	0.08	20.0	0.07	6.0	0.29
	0.30	0.10	30.0	0.11	9.0	0.12
	0.40	0.22	40.0	0.15	12.0	0.12
	0.50	0.21	50.0	0.12	15.0	0.07
	0.60	0.16	60.0	0.07	18.0	0.03
	0.70	0.10	70.0	0.07	21.0	0.03
	0.80	0.09	80.0	0.42	24.0	0.02
	0.90	0.03	90.0	0.02	27.0	0.01
	1.00	0.02	100.0	0.00	30.0	0.01
	1.10	0.01	110.0	0.00	33.0	0.01
	1.20	0.01	120.0	0.00	36.0	0.00
	1.30	0.00	130.0	0.00	39.0	0.01
	> 1.35	0.00	> 135.0	0.00	> 40.5	0.01
Total:		1.00		1.00		1.00

Table E-3. Summary of flake geometry amalysis for aspen core furnish (collected after dryer and screener).

TABLE ID: PLGS - 23
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mill Trial — Date: March 7, 1990
Proj. No.: 406-023-00 — Material: Aspen, 03/01/90
Comments: 7.8% fines removed (<3/8")

Data File: plgs23 — Disk ID: PLGD - 23

No. of Samples: 200

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.63	56.1	9.1	8.94	98.3
Std. Deviation	0.24	21.4	6.9	6.73	48.5
95 % C.I. +/-	0.03	3.0	1.0	0.93	6.7
Upper Limit	0.67	59.1	10.1	9.87	105.0
Lower limit	0.60	53.2	8.2	8.00	91.6
Low	0.21	11.8	1.6	1.09	7.3
Median	0.62	59.3	7.4	6.84	97.0
High	1.98	84.6	42.1	44.07	283.3

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.00
	0.10	0.00	10.0	0.01	3.0	0.24
	0.20	0.01	20.0	0.06	6.0	0.28
	0.30	0.07	30.0	0.17	9.0	0.23
	0.40	0.10	40.0	0.19	12.0	0.08
	0.50	0.15	50.0	0.06	15.0	0.06
	0.60	0.26	60.0	0.08	18.0	0.05
	0.70	0.20	70.0	0.08	21.0	0.02
	0.80	0.09	80.0	0.37	24.0	0.01
	0.90	0.05	90.0	0.00	27.0	0.02
	1.00	0.04	100.0	0.00	30.0	0.01
	1.10	0.01	110.0	0.00	33.0	0.01
	1.20	0.01	120.0	0.00	36.0	0.01
	1.30	0.02	130.0	0.00	39.0	0.00
	> 1.35	0.02	> 135.0	0.00	> 40.5	0.01
Total:		1.00		1.00		1.00

Table E-4. Summary of flake geometry analysis for black poplar face furnish (collected after dryer and screener).

TABLE ID: PLGS - 24
FLAKE GEOMETRY ANALYSIS SUMMARY
ALBERTA RESEARCH COUNCIL FOREST PRODUCTS PROGRAM
PANEL DEVELOPMENT LABORATORY

Project: Mill Trial — Date: March 7, 1990
Proj. No.: 406-023-00 — Material: B.P.; 03/01/90
Comments: Mill Dried, 9.4% fines removed

Data File: plgs24 — Disk ID: PLGD - 23

No. of Samples: 200

	Thickness (mm)	Length (mm)	Width (mm)	Aspect Ratio	Slenderness Ratio
Mean	0.62	58.1	8.2	10.67	101.0
Std. Deviation	0.20	19.5	6.8	7.67	43.0
95 % C.I. +/-	0.03	2.7	0.9	1.06	6.0
Upper Limit	0.65	60.8	9.1	11.73	106.9
Lower limit	0.60	55.4	7.2	9.61	95.0
Low	0.21	20.3	1.4	1.30	22.6
Median	0.60	61.0	6.5	8.59	100.0
High	1.55	84.4	49.7	49.07	237.7

Flake Geometry Frequency Distribution

	Thickness		Length		Width	
Class Interval:	0.10 mm		10.0 mm		3.0 mm	
	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.	Class (mm)	Relative Freq.
	<= 0.05	0.00	<= 5.0	0.00	<= 1.5	0.01
	0.10	0.00	10.0	0.00	3.0	0.32
	0.20	0.01	20.0	0.02	6.0	0.23
	0.30	0.04	30.0	0.16	9.0	0.23
	0.40	0.17	40.0	0.16	12.0	0.09
	0.50	0.24	50.0	0.10	15.0	0.05
	0.60	0.14	60.0	0.12	18.0	0.03
	0.70	0.18	70.0	0.09	21.0	0.03
	0.80	0.12	80.0	0.36	24.0	0.01
	0.90	0.05	90.0	0.00	27.0	0.01
	1.00	0.04	100.0	0.00	30.0	0.01
	1.10	0.01	110.0	0.00	33.0	0.00
	1.20	0.01	120.0	0.00	36.0	0.00
	1.30	0.01	130.0	0.00	39.0	0.00
	> 1.35	0.01	> 135.0	0.00	> 40.5	0.02
Total:		1.00		1.00		1.00

Appendix F

Individual Panel Test Results from Pilot Plant Trial

Table F-1. Summary of grade properties for OSB made of aspen in the core and aspen in the face.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437-M85)

Client: A.R.C.
Test Date: January 9, 1990
Proj.Ref.: 40601300

Test Material: O.S.B.
Nom. Thickness: 11.0 mm
Conditioning: As per Test Requirement

	Units	CAN3-0437 O-2 Req.	Dir'n	A1	A2	A3	A4	A5	5 Panel Average
Modulus of rupture	MPa	29.0	Para	40.7	50.6	47.6	43.4	44.3	45.3
		12.4	Perp	18.2	20.3	12.9	17.1	16.6	17.0
Modulus of elasticity	MPa	5500	Para	7100	7800	7400	7500	7000	7400
		1500	Perp	2300	2400	1800	2000	2200	2100
Internal bond	MPa	0.345	N/A	0.499	0.456	0.489	0.496	0.466	0.481
Bond durability - MOR after 2 h boil	MPa	14.5	Para	22.4	21.7	22.0	21.4	21.7	21.8
		6.2	Perp	9.4	9.6	9.0	7.2	8.5	8.7
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25	N/A	14	15	14	16	17	15
Linear expansion - oven dry to saturated	%	0.40	Para	0.18	0.20	0.20	0.22	0.20	0.20
		0.40	Perp	0.38	0.37	0.40	0.46	0.42	0.40
Moisture Content -	%	Max. 8.0	N/A	3.0	3.0	3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		692	641	693	622	670	663

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Table F-2. Summary of grade properties for OSB made of aspen in the core and 50:50 mix of aspen and black poplar in the face.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437-M85)

Client: A.R.C.
Test Date: January 9, 1990
Proj.Ref.: 40601300

Test Material: O.S.B.
Nom. Thickness: 11.0 mm
Conditioning: As per Test Requirement

	Units	CAN3-0437 O-2 Req.	Dir'n	AB1	AB2	AB3	AB4	AB5	5 Panel Average
Modulus of rupture	MPa	29.0	Para	33.5	40.9	35.0	44.9	39.9	39.1
		12.4	Perp	21.0	15.3	15.8	16.7	16.2	17.0
Modulus of elasticity	MPa	5500	Para	6700	6900	6500	7700	7700	7100
		1500	Perp	2700	2000	2100	2300	2500	2300
Internal bond	MPa	0.345	N/A	0.398	0.451	0.490	0.443	0.367	0.430
Bond durability - MOR after 2 h boil	MPa	14.5	Para	19.6	20.2	20.2	17.7	22.2	20.0
		6.2	Perp	11.0	9.8	9.0	9.0	10.1	9.8
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25	N/A	17	17	15	16	17	16
Linear expansion - oven dry to saturated	%	0.40	Para	0.24	0.23	0.22	0.21	0.20	0.22
		0.40	Perp	0.38	0.37	0.41	0.37	0.40	0.38
Moisture Content -	%	Max. 8.0	N/A	3.0	3.0	3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		687	640	658	648	700	667

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Table F-3. Summary of grade properties for OSB made of aspen in the core and black poplar in the face.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437-M85)

Client: A.R.C.
Test Date: January 9, 1990
Proj.Ref.: 40601300

Test Material: O.S.B.
Nom. Thickness: 11.0 mm
Conditioning: As per Test Requirement

	Units	CAN3-0437 O-2 Req.	Dir'n	B1	B2	B3	B4	B5	5 Panel Average
Modulus of rupture	MPa	29.0	Para	39.1	42.5	41.0	44.7	43.0	42.1
		12.4	Perp	14.5	13.8	17.3	19.5	19.3	16.9
Modulus of elasticity	MPa	5500	Para	7200	7400	7000	7300	7500	7300
		1500	Perp	1800	1900	2000	2500	2400	2100
Internal bond	MPa	0.345	N/A	0.395	0.395	0.428	0.504	0.477	0.440
Bond durability - MOR after 2 h boil	MPa	14.5	Para	19.0	21.4	21.0	22.7	23.3	21.5
		6.2	Perp	8.5	7.6	8.2	10.7	8.7	8.7
Thickness swell - 24 h soak - 12.7 mm or thinner	%	25	N/A	16	14	16	15	16	15
Linear expansion - oven dry to saturated	%	0.40	Para	0.25	0.27	0.26	0.24	0.23	0.25
		0.40	Perp	0.36	0.38	0.43	0.34	0.35	0.37
Moisture Content -	%	Max. 8.0	N/A	3.0	3.0	3.0	3.0	3.0	3.0
Density -	kg/cu.m	No Requirement		672	670	670	664	687	673

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ALBERTA RESEARCH COUNCIL

FOREST PRODUCTS LABORATORY

Appendix G

Individual Panel Test Results from Mill Trial

Table G-1. Summary of grade properties for control OSB (aspen in core and aspen in face).

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437-M85)

Client: A.R.C.
Test Date: March 14, 1990
Proj.Ref.: 40601300

Test Material: O.S.B. (ASPEN)
Nom. Thickness: 11.0 mm
Conditioning: As per Test Requirement

	Units	CAN3-0437 O-2 Req.	Dir'n	A-1	A-2	A-8	A-16	A-18	5 Panel Average
Modulus of rupture	MPa	29.0	Para	31.6	31.3	23.9	32.6	34.1	30.7
	MPa	12.4	Perp	19.5	21.3	19.0	17.3	18.2	19.1
Modulus of elasticity	MPa	5500	Para	7200	6500	5400	6800	7200	6600
	MPa	1500	Perp	2900	2900	2600	2300	2500	2600
Internal bond	MPa	0.345	N/A	0.416	0.469	0.395	0.377	0.411	0.414
Bond durability -	MPa	14.5	Para	17.1	16.5	16.3	14.4	15.7	16.0
MOR after 2 h boil	MPa	6.2	Perp	12.0	11.4	11.1	9.9	10.1	10.9
Thickness swell - 24 h soak - 12.7 mm. or thinner	%	25	N/A	15	14	14	12	12	14
Linear expansion -	%	0.40	Para	0.15	0.17	0.18	0.18	0.17	0.17
oven dry to saturated		0.40	Perp	0.25	0.26	0.29	0.27	0.32	0.28
Lateral nail expansion	N	770	Para	1154	1027	999	1229	1181	1118
		770	Perp	970	1304	1502	1089	1358	1245
Moisture content	%	No Req.	N/A	3.0	2.0	2.0	2.0	2.0	2.0
Density	kg/cu.m	No Req.	N/A	612	703	654	677	653	660

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FOREST PRODUCTS LABORATORY

Table G-2. Summary of grade properties for trial OSB (aspen in core and black poplar in face) sampled from press load #12.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437-M85)

Client: A.R.C.
Test Date: March 14, 1990
Proj.Ref.: 40601300

Test Material: O.S.B. (PC 12)
Nom. Thickness: 11.0 mm
Conditioning: As per Test Requirement

	Units	CAN3-0437 O-2 Req.	Dir'n	B-3	B-5	B-6	B-8	B-9	5 Panel Average
Modulus of rupture	MPa	29.0	Para	26.5	28.6	19.8	26.8	26.8	25.7
	MPa	12.4	Perp	17.0	15.8	20.4	17.8	17.6	17.7
Modulus of elasticity	MPa	5500	Para	5700	5800	5200	5700	5600	5600
	MPa	1500	Perp	2100	2400	2500	2300	2100	2300
Internal bond	MPa	0.345	N/A	0.361	0.445	0.313	0.445	0.420	0.397
Bond durability -	MPa	14.5	Para	13.1	14.2	16.1	15.3	15.1	14.7
MOR after 2 h boil	MPa	6.2	Perp	9.6	8.9	11.0	8.0	9.9	9.5
Thickness swell - 24 h soak - 12.7 mm. or thinner	%	25	N/A	18	20	17	17	15	17
Linear expansion -	%	0.40	Para	0.19	0.23	0.25	0.20	0.16	0.21
oven dry to saturated		0.40	Perp	0.30	0.28	0.29	0.29	0.29	0.29
Lateral nail expansion	N	770	Para	918	971	946	1084	1046	993
		770	Perp	795	1088	1020	1192	1166	1052
Moisture content	%	No Req.	N/A	1.0	2.0	2.0	2.0	3.0	2.0
Density	kg/cu.m	No Req.	N/A	599	613	582	647	600	608

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Table G-3. Summary of grade properties for trial OSB (aspen in core and black poplar in face) sampled from press load #13.

SUMMARY TABLE
GRADE PROPERTIES
(CAN3-0437-M85)

Client: A.R.C.
Test Date: March 14, 1990
Proj.Ref.: 40601300

Test Material: O.S.B. (PC 13)
Nom. Thickness: 11.0 mm
Conditioning: As per Test Requirement

	Units	CAN3-0437 O-2 Req.	Dir'n	B-10	B-12	B-13	B-17	B-20	5 Panel Average
Modulus of rupture	MPa	29.0	Para	27.2	25.9	26.4	23.0	25.9	25.7
	MPa	12.4	Perp	15.4	21.3	18.8	19.7	17.9	18.6
Modulus of elasticity	MPa	5500	Para	5800	5300	5300	5100	5600	5400
	MPa	1500	Perp	2200	2300	2500	2700	2300	2400
Internal bond	MPa	0.345	N/A	0.355	0.383	0.303	0.393	0.388	0.364
Bond durability - MOR after 2 h boil	MPa	14.5	Para	12.3	12.8	11.5	12.7	13.1	12.5
	MPa	6.2	Perp	9.5	11.5	10.1	10.8	9.4	10.3
Thickness swell - 24 h soak - 12.7 mm. or thinner	%	25	N/A	23	17	21	18	17	19
Linear expansion - oven dry to saturated	%	0.40	Para	0.27	0.21	0.26	0.20	0.19	0.23
		0.40	Perp	0.31	0.30	0.37	0.26	0.32	0.31
Lateral nail expansion	N	770	Para	848	838	754	796	790	805
		770	Perp	883	805	920	904	859	874
Moisture content	%	No Req.	N/A	2.0	1.0	2.0	2.0	2.0	2.0
Density	kg/cu.m	No Req.	N/A	605	603	580	576	602	593

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FOREST PRODUCTS LABORATORY